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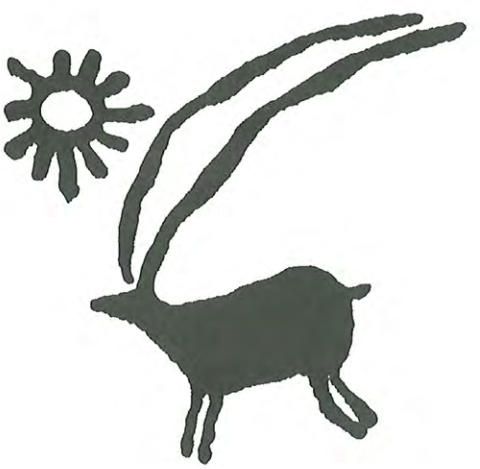

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Muerte en el Canal: experiencias bioestratinómicas controladas sobre la acción sustractora de Cánidos

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RESUMEN: Durante nuestro proyecto etnoarqueológico en el Canal Beagle (Tierra del Fuego, Argentina) se realizó un vasto programa de experimentación tafonómica para comprender la dinámica de formación de los sitios estudiados. Aprovechando la perfecta adecuación del lugar se han seguido los procesos bioestratinómicos en tres especies de herbívoros (guanaco, vaca y oveja) y la conducta de carroñeo del zorro patagónico sobre ellas. Se ha puesto de manifiesto que la conducta de esos cánidos no tiene una consecuencia tafonómica de acumulación sino de sustracción de restos y que la actitud humana cambia ese comportamiento y la trascendencia que ello tiene de cara a inferencias tafonómicas e interpretación de conjuntos arqueológicos prehistóricos en la zona.

PALABRAS CLAVE: BIOESTRATINOMÍA, ARQUEO-TAFONOMÍA, CARROÑEO, ZORRO

ABSTRACT: As part of our ethnoarchaeological research project in Beagle Canal (Tierra del Fuego, Argentina) an extensive program of taphonomic studies was undertaken in order to understand site formation processes in the area. The landscape was particulary suited for carrying out controled bioestratinomic researches on three species of herbivores (guanaco, cattle and sheep) and on the exploitation of carcasses by the Patagonian fox. The importance of considering the action of small carnivores for the evaluation of taphonomic loss was evident. Our studies stress the need to evaluate the relationship between foxes and the inhabitants of prehistoric campsites as well as the occupation frequencies of specific sites if one hopes to reach acceptable palaeoeconomic inferences about them.

KEY WORDS: BIOSTRATINOMY, ARQUEO-TAPHONOMY, SCAVENGERS, FOXES

INTRODUCCIÓN

El estudio actualístico de los procesos de fosildiagénesis, la tafonomía (definida en 1940 por Efremov), desde el estudio de los procesos de muerte y descomposición, la bioestratinomía de Weigelt (1927), hasta los de enterramiento y fosilización de los animales muertos permitió deshacer algunas interpretaciones paleontológicas (paleobiológicas, paleoecológicas y bioestratigráficas) erradas; al mismo tiempo demostró la necesidad de un cambio radical en los métodos de recogida de datos en Paleontología por la obligatoriedad de tener en cuenta el contexto. Ese proceso de valoración del contexto y de las relaciones estructurales entre los datos ha sido paralelo en Paleontología, Arqueología y Sedimentología (p.e. las técnicas de micromorfología, Kubiena, 1938).

De la misma forma, el análisis arqueológico de sociedades recientes permite controlar las bases actualísticas y analógicas de la disciplina, así como su adecuación metodológica e instrumental (Estévez & Vila, 1995). Así el desarrollo de las llamadas teorías de rango medio ha permitido una

cierta revitalización de la representación de sociedades prehistóricas.

En la intersección de esas dos primeras ciencias, en Arqueozoología, las observaciones y la experimentación tafonómica y etnoarqueológica han puesto en cuestión tesis sobre la vida en las sociedades prehistóricas que se habían dado casi por irrefutables (p.e. Binford, 1981; Brain, 1981).

Fue también esa necesidad de desarrollo metodológico en Arqueología la que nos llevó, en 1986, a iniciar un proyecto de Etnoarqueología en Tierra del Fuego y a desarrollar, consecuentemente, un vasto programa de experimentación paralelo a las excavaciones arqueológicas (Piana *et al.*,1992; Estévez, 1995; Estévez & Vila, 1995) que nos permitiera establecer los parámetros significativos que han intervenido en los procesos de formación de los sitios. Lo que presentamos aquí no es más que una pequeña parte de ese proyecto tafonómico paralelo que se enmarcó dentro de un marco más vasto[1].

PRECEDENTES Y OBJETIVOS DEL PROYECTO EN TAFONOMÍA

Las experiencias tafonómicas han demostrado la necesidad ineludible de realizar evaluaciones sobre el proceso de formación de los sitios arqueológicos y paleontológicos (Lyman, 1994).

Los experimentos y seguimientos tafonómicos actualistas se multiplicaron desde el redescubrimiento de la tafonomía por parte de autores anglosajones como Voorhies, Behrensmeyer, Hill y sobre todo con su aplicación a la Arqueología por Gifford, Shipman y Binford (cf. Blasco, 1992). Hoy se dispone de una abundante documentación tanto sobre la actividad acumuladora como sobre elementos discriminantes de la acción carnívora y carroñera. Pero la multiplicidad de factores intervinientes particularizan las circunstancias de formación de los yacimientos dificultando la formulación de leyes generales. Es necesario tratar ese problema discretizando, reduciendo y aislando las variables.

El principal problema que se ha abordado en Arqueotafonomía es el de la magnitud y calidad de la participación de los humanos en las acumulaciones de huesos en los yacimientos paleolíticos (Blasco, 1992), el poder identificar la acción acumuladora de los grandes carnívoros y el discriminar entre muerte natural o aportación antrópica.

Si Brain (1981) abrió el tema cuestionando el papel de *Australopithecus* en las acumulaciones de las formaciones kársticas de Africa del Sur, que habían constituido trampas sedimentarias, Binford planteó la duda sobre la aportación humana primaria en yacimientos peri-lacustres del Africa oriental y en los de las cuevas del Paleolítico medio en Europa (Binford, 1981).

Toda esta temática ha sido muy estimulada por la polémica que rodea (tanto en Europa como en América) la búsqueda de las primeras ocupaciones humanas y la pretensión de reconocer trazas de las actividades antrópicas en yacimientos con pocos indicios.

En Tierra del Fuego, y siguiendo la línea marcada por Binford, Borrero (1989) se replanteó el papel de los humanos en las acumulaciones de huesos de guanaco. Llevó a cabo una serie de observaciones siguiendo la idea de que los guanacos podían haber muerto sobre los lugares de ocupación humana al aire libre, dando lugar a heterogeneidad y, por lo tanto, a posibles explicaciones paleoeconómicas equivocadas.

Además de las zonas anegadas y kársticas, posiblemente haya casos especiales como los que presenta Borrero, donde determinadas caracterísicas topográficas obliguen a una concentración espacial que pueda hacer coincidir un lugar de ocupación al aire libre con una serie cuantiosa de muertes o depositaciones naturales de animales, en los que se dé, además, un tipo de sedimentación que imposibilite el reconocimiento de la diferencia durante el proceso de excavación.

Si bien ese tipo de problemas de generación de palimpsestos puede ser una cuestión relevante en muchos yacimientos paleolíticos (kársticos o lacustres) que pueden considerarse verdaderas trampas sedimentarias, parecería que este tipo de encuesta debería ser poco relevante en otros yacimientos arqueológicos cuya generación es básica-

[1] Proyecto ALAMED de la Unión Europea "Marine resources at the Beagle Channel prior to the industrial exploitation: an archaeological evaluation" (1993-1996) financiado por la Unión Europea, el CONICET (Argentina) y la DGICYT (España), y previamente de los de "Secuencia del poblamiento de la costa norte del Canal Beagle" del CONICET y CADIC (Centro Austral de Investigaciones Científicas) combinado con el de "Contrastación arqueológica de la imagen etnográfica de los canoeros magallánico-fueguinos de la Costa Norte del Canal Beagle (Tierra del Fuego, Argentina).

mente antrópica. Efectivamente, este es el caso de poblados o de campamentos al aire libre donde es realmente difícil que por azar se haya producido tal coincidencia en forma significativa. En el caso de los concheros de Tierra del Fuego, por ejemplo, probablemente la reocupación de los sitios de costa era lo suficientemente rápida como para que los guanacos no establecieran sus senderos o apostaderos fijos sobre campamentos abandonados, y que por lo tanto dejarán suficientes restos como para dar pie a errores sustanciales. Por otro lado, el rápido proceso de sedimentación en estos concheros es bien conocido y el sistema de excavación implementado haría difícil confundir una acumulación antrópica en una unidad de ocupación de gente canoera con una acumulación natural (Piana & Orquera, 1995; Taulé, 1995). Finalmente, las trazas antrópicas sobre los huesos están perfectamente conservadas, son muy frecuentes y sobradamente reconocibles para nosotros.

Así pues, nuestros objetivos se dirigieron al problema inverso, que sí puede ser relevante en cualquier asentamiento antrópico abandonado: No tratamos de ver el efecto acumulador, sino el de la pérdida tafonómica pre-depositacional en cadáveres de animales abandonados y el de la secuencia de su descomposición y desarticulación.

Pensamos que la acción humana es menos compatible con la de los grandes carnívoros (felinos, hienas, lobos, etc), que han acaparado el máximo interés en los estudios tafonómicos orientados a discernir los factores de la acumulación, que la interacción con los pequeños carnívoros. Estos, pasando más desapercibidos, pueden llegar a simultanear prácticamente su acción con la actividad antrópica. A pesar de ello su efecto ha sido menos estudiado que el de los animales mayores (Haynes, 1983; Stallibrass, 1984; Andrews, 1995).

El control de estos procesos de sustracción de restos por pequeños carnívoros puede ser más significativo que el de adición no sólo en nuestro caso de los conchales de Tierra del Fuego, sino que también pueden extraerse informaciones útiles en otros tipos de yacimientos antrópicos más comunes en la Prehistoria reciente.

Tierra del Fuego como "laboratorio" de observaciones controladas

La costa norte del Canal Beagle donde se desarrollaron nuestras actividades tiene una serie de características que hacen muy viable e interesante la realización de observaciones tafonómicas.

El ambiente no es todo lo virgen que muchos pudieran suponer: la actividad humana ha estado incidiendo en él desde hace más de 6.500 años (Orquera & Piana, 1983; Piana, 1984), y ha sido realmente crítica a partir del siglo pasado por la incidencia de las explotaciones industriales de animales marinos, las empresas madereras y las ganaderas. Sin embargo, la densidad de población actual es muy baja (y muy concentrada en la capital, Ushuaia), y la abundancia faunística grande. La incidencia directa de los humanos en las zonas donde realizamos nuestros trabajos es muy baja, por lo que tampoco cabe esperar que la fauna salvaje debería tener, en principio, un comportamiento demasiado distorsionado. Por ello, se pueden registrar procesos naturales a lo largo de períodos largos sin grandes riesgos de perturbación.

El ambiente está dominado hoy por el bosque de *Nothofagus*, que alterna con zonas abiertas de pasto y turberas. El mayor mamífero terrestre es el ganado vacuno (*Bos taurus*), introducido por los europeos, el siguiente en tamaño es el guanaco (*Lama glama guanicoe*), siendo dominantes las ovejas europeas (*Ovis aries*) de las estancias ganaderas.

El guanaco es el único gran herbívoro autóctono. En Tierra del Fuego pesan hasta 139 kg, con una media de 119 kg (Raedecke, 1976:104). Tienen distribución amplia sobre zonas de estepa, montaña, valles y turbales altos y bajos. En la región del Beagle su presencia estuvo aparentemente restringida a las porciones central y oriental de la costa norte y a la isla Navarino. En esta región no se han realizado estudios sobre su comportamiento pero en regiones vecinas forman grupos familiares de 7-8 individuos en promedio (con un máximo de 30), o grupos de machos de hasta 50 individuos (Raedecke, 1976:108); también se ven individuos aislados.

Esas tres especies (vaca, guanaco y oveja), de tamaño distinto y, en cierto modo, paralelizable al de las diferentes categorías de herbívoros más comunes en los sitios prehistóricos europeos, eran idóneas para realizar un registro de observaciones contrastantes.

Las aves, terrestres y acuáticas, y, hasta 1991, el conejo europeo (*Oryctolagus cuniculus*), introducido, son muy abundantes y constituyen un contrapunto de vertebrados de tamaño pequeño.

El único carroñero grande es el zorro gris (*Dusicyon griseus*), introducido desde Patagonia continental, que en la zona de estudio ha substituido, desde hace 10 años, al autóctono zorro colorado (*Dusicyon culpaeus*), especie de mayor tamaño. Aparte de este mamífero, básicamente sólo cuatro aves ejercen el carroñeo sobre los cadáveres de esos herbívoros: el cóndor (*Vultur gryphus*), el jote de cabeza colorada (*Cathartes aura*), el carancho (*Polyborus plancus*) y el chimango (*Milvago chimango*). Los más habituales son los dos últimos, y no hemos presenciado ningún episodio de carroñería sobre los especímenes observados protagonizado por las dos primeras especies o por gaviotas (*Larus dominicanus*) en este lugar, aunque sí los hemos visto en otras zonas cercanas, junto a la costa.

La poca variedad de carroñeros involucrados y el ser precisamente de pequeña talla en la zona convierten estas experiencias en un verdadero experimento controlado en condiciones privilegiadas. Efectivamente, realizar las observaciones en las condiciones naturales (tal como hemos podido hacer también con aves y conejos en Tierra del Fuego) permite soslayar los problemas que se nos presentaron en los experimentos que habíamos realizado desde 1984 con distintas especies de carnívoros en cautividad en el Zoológico de Barcelona, sin perder la ventaja de controlar a un solo carroñero principal. La posibilidad de seguir además su efecto sobre especies de herbívoros de tres tamaños diferentes aumenta el poder heurístico del experimento.

La mortandad catastrófica provocada por las copiosas nevadas del invierno fueguino de 1995 nos proporcionó además una ocasión única de observar la descomposición y el carroñeo por zorros y aves sobre una enorme cantidad de cadáveres de las tres especies animales mencionadas. No sólo eso, sino que pudimos observar el efecto de nuestro propio campamento sobre la conducta de algunos de los carroñeros que frecuentaban o habitaban en sus inmediaciones.

Estas observaciones se confrontaron además con las realizadas con animales más pequeños, aves por ejemplo. El registro completaba las observaciones que habíamos realizado en las campañas anteriores, en ese mismo sitio y en otra zona a unos 60 Km al oeste. Las anotaciones se continuaron en lapsos regulares hasta el final del verano de 1997. La experiencia, pues, abarcó el control de la descomposición y la dispersión de los restos de cadáveres correspondientes a animales de distintas tallas en un lapso de tres años.

El estudio se llevó con mayor detalle de control de variables sobre el ungulado de tamaño mediano. Amén de ser el métricamente intermedio (equiparable en tamaño a nuestro ciervo) es el único autóctono de los tres y el más representativo de los sitios arqueológicos de Tierra del Fuego y de la Patagonia continental.

En sentido estricto esta investigación es más bien un experimento de bioestratinomía (Weigelt, 1927), puesto que sólo pretendimos seguir el proceso hasta la integración de los restos en una matriz sedimentaria.

Planteamiento inicial y premisas

Planteamos la hipótesis de que un cadáver animal es carroñeado en una intensidad, "grosso modo", logarítmicamente decreciente, aunque en el detalle se puedan percibir sucesivas fases puntuales de equilibrio o inactividad. Por tanto el efecto de la desarticulación y dispersión de los restos no sería un fenómeno continuo sino que llega casi a estabilizarse. Lo mismo podría suponerse del efecto de dispersión provocado por la acción de la gravedad e hídrica (en este caso también del hielo y deshielo). Otro planteamiento de partida fué que en la reacción de los animales debe ser tenida en cuenta, también, la modificación de conductas que puede provocar en ellos la acción humana.

Metodológicamente compartimos la aproximación dialéctica de Efremov (Olson, 1980), pero no su escepticismo frente a las aproximaciones estadísticas. Sin embargo, después de una ya larga experiencia (Estévez, 1977-78) también rechazamos el "fetichismo" de cierto positivismo hacia la estadística, la necesidad de redundancias experimentales, y los números "mágicos" (Barceló *et al.*, 1994).

Las observaciones experimentales

Nuestro campamento se hallaba ubicado en la estancia ganadera (de bovinos y ovinos) Harberton, dentro de un bosque viejo de *Nothofagus pumilio*, en una pequeña terraza a 10 metros sobre el nivel del mar y a unos 30 m sobre la costa de la bahía Cambaceres interior.

En un radio inferior a los 500 metros existe un mosaico de vegetación que va desde ese bosque viejo de grandes lengas (*Nothofagus pumilio*) hasta

espacio de turbal, pasando por bosquecillos jóvenes, más densos, de ñires (*Nothofagus antarctica*).

Las manadas de guanacos de esta costa norte del Canal Beagle tienen un comportamiento migratorio que las lleva a zonas más altas del interior en octubre-noviembre, y de las que descienden con las primeras nevadas de abril para buscar alimento y refugio en las zonas bajas. Esta migración es muy corta por el relieve accidentado y abrupto de la región, y el Canal representa una barrera inferior netamente definida. Estas condiciones y conducta hacen que los rebaños de animales domésticos y salvajes se concentren, gran parte del año, en una estrecha franja litoral. El estrés alimentario puede ser, en invierno, muy duro. Por ello no es de extrañar que se produzcan numerosas muertes en un momento y en un área muy restringidos.

En el invierno de 1995, y debido a las condiciones meteorológicas que hemos comentado, perecieron, probablemente en un único episodio, dos pequeñas manadas enteras de hembras con chulengos. La mayoría de estas muertes debieron producirse por congelamiento o por cubrimiento níveo pues muchos de los animales estaban al final de una senda perfectamente reconocible, en posición y lugares de descanso y cobijo, bajo un árbol, rodeados de bosteaderos y, en algunos casos, en grupos de dos o tres. Ya con un patrón más disperso se encontraron también otros animales, muertos probablemente por colapso, desnutrición o accidente, enredados en las ramas de los árboles o en los cercos, que debieron quedar peligrosamente disimulados y convertidos en trampas por la potente cobertura de nieve.

Evidentemente, en años como éstos la costa del Canal Beagle constituye un "cul de sac" del que no pueden escapar los animales en busca de lugares menos rigurosos.

El ganado vacuno y ovino resultó igualmente afectado este invierno de 1995, y se encontraron cadáveres de vacas y ovejas agrupados en lugares a los que debían haber acudido en busca de refugio.

Por todo lo anterior, tuvimos la oportunidad de controlar casi medio centenar de cadáveres de las tres especies, que se sumaron a los que habíamos observado el año anterior.

Por grupos controlamos, gráfica y métricamente, 32 guanacos y una veintena de animales domésticos. Este límite, en el caso de los animales domésticos, vino determinado por una redundancia suficientemente significativa del patrón de carroñeo y desarticulación.

VARIABLES TENIDAS EN CUENTA Y SISTEMA DE REGISTRO

Las variables que consideramos significativas fueron agrupadas en tres categorías: 1) las referidas al ambiente, 2) las descriptivas de la carcasa y 3) las descriptivas de la acción carroñera.

Los individuos se situaron con GPS y sobre un mapa para facilitar su localización en los seguimientos sucesivos (Figura 1). De todos ellos se realizó un registro fotográfico y mapeo a escala 1:10 con croquis.

Las variables que se registraron respecto al ambiente están relacionadas con las posibles circunstancias de la muerte (cercanía a agua, comida, senda, trampas, altura de cobertura nívea, en relación a las trazas de ramoneo inmediato), con la visibilidad del cuerpo (cobertura vegetal), con las circunstancias deposicionales (otras carcasas cercanas, exposición solar y substrato, topografía, carácter y humedad) y con observación directa de carroñeros.

Las variables descriptivas de la carcasa hacen referencia a las características del individuo (sexo, edad, orientación, posición y momento probable de la muerte), a las de la carcasa (partes representadas, estado de conservación del cuero, de otras partes blandas y de los huesos), a la dispersión (existencia de aureola de descomposición sobre el substrato, medida del radio máximo y de las distancias entre

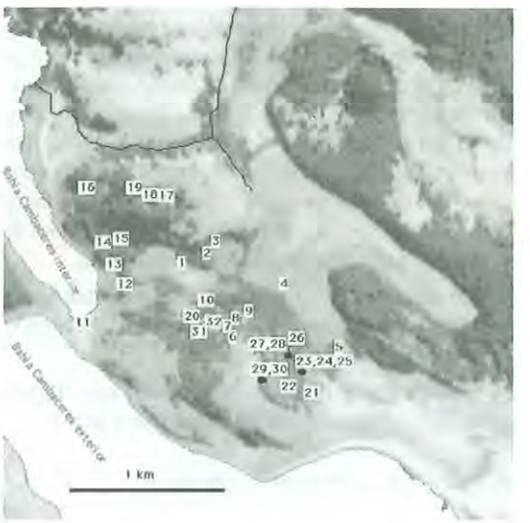

FIGURA 1
Mapa y localización de las carcasas de guanacos monitoreadas.

las partes) y al entorno conductual pre-mortem (remoción del suelo, excrementos, etc).

Las variables relacionadas con la modificación en la disposición del cadáver registran los agentes actuantes (invertebrados, aves, zorros, otros herbívoros, gravedad, vegetación), sus señales (picotazos, mordiscos, pisoteo, excrementos), localización de las mismas, y la secuencia de daños observada.

Disposición de los cadáveres

Hay que reseñar que, tal como suponíamos y a pesar de la altísima densidad de cadáveres, los lugares de mortandad de las diferentes especies no se solaparon, y tampoco, a pesar de la altísima densidad de sitios arqueológicos, se produjo ni una sola superposición de cadáveres sobre yacimientos.

Las sendas de los guanacos y de los otros herbívoros coinciden en parte; sin embargo, los primeros son más ágiles lo que les permite, en condiciones normales, saltar los cercados y seguir rutas propias. Por ello sólo se produjeron dos casos en los que, al coincidir las sendas, se podía haber producido un pisoteo de los restos que no fue, sin embargo, constatado. En cambio, se produjo la muerte de un guanaco atrapado en el mismo árbol en el que se refugió y murió el año anterior otro guanaco. Los restos de este primero presentaban fracturas de pisoteo.

Los cadáveres depositados en zonas abiertas, con visibilidad desde el aire y exposición solar, fueron mucho más carroñeados y perdieron mucho antes todos los tejidos blandos que los que estaban en zonas de sombra y en el bosque tupido. Sólo se hizo un avistamiento de un ave carroñera en el bosque, mientras que la presencia de zorros alrededor de la carroña era casi constante. Además de los zorros y las aves carroñeras se observó intensa actividad de invertebrados que atraían sobre el cadáver a pequeñas aves insectívoras. Sólo se constató la presencia de un roedor pequeño en un caso.

Un cadáver depositado en la playa de una bahía interior estuvo expuesto al carroñeo alternando con la acción de las olas.

Como regla general los cadáveres menos expuestos a la humedad se conservaron mejor.

Actuación de zorros sobre guanacos

La gran abundancia de carcasas favoreció este año 1996 el éxito reproductivo y una gran densidad en la población de zorros.

La búsqueda e ingestión de alimento por parte de este carnívoro tiene lugar tanto de día como de noche y cada individuo cuida celosamente la carcasa de la que se está alimentando.

En muchos de los cadáveres de guanacos pudimos constatar la presencia, a pocos metros, de una madriguera de zorro, aunque no todas estaban ocupadas constantemente. Posiblemente cada zorro había construido más de una madriguera, que ocuparía intermitentemente, controlando así varias carroñas. Todas ellas estaban marcadas con excrementos de zorro y algunas con excrementos de ave.

Al inicio de nuestras observaciones el carroñeo ya estaba recién iniciado en todos los ejemplares y avanzaba a ritmos distintos. Esto nos permitió secuenciar la acción de los zorros. Si bien las variables que hemos remarcado influyen definiendo unas realidades distintas, se puede establecer un patrón conductual recurrente para la secuencia de aprovechamiento de las carroñas por parte del zorro.

En el caso del guanaco lo primero en ser atacado es la parte posterior del vientre para, perforándolo, acceder a las vísceras. Después, el ataque continúa por el morro y las orejas. Aquí se pueden visualizar daños en los huesos premaxilares y nasales. El carroñeo sobre el cráneo puede seguir por la parte posterior, con lo que el atlas queda desarticulado. Dependiendo de la posición del cadáver, el ataque ventral puede seguir hacia la parte delantera (produciendo daños y desarticulación de costillas y esternebras) o hacia la pelvis (daños iniciales sobre el ilion y posteriormente sobre otros márgenes de la pelvis). Sigue otra fase en la que se empieza a atacar la zona inmediatamente posterior a las patas delanteras. Esto puede producir la desarticulación de las mismas cuando desaparece totalmente el cuero que une las patas al tronco. Casi al mismo tiempo, empieza un carroñeo con tracción de la articulación fémur-tibia o, si todavía no está desarticulada la pata delantera, de la articulación distal del húmero. Ese ataque y tracción se pueden concentrar también a nivel de metapodios con lo que se desarticulan los *basipodia* que se pueden transportar lejos.

La forma de actuación de los zorros es desde nuestro punto de vista muy relevante puesto que pudimos observar cómo los animales se acercan a la carcasa, arrancan un pedazo en el mínimo tiempo posible, se retiran con él unos metros y lo muerden, reducen e ingieren. Una hembra con cachorros puede transportar la comida hasta varios centena-

res de metros, al sitio donde ha dejado a sus cachorros.

Resultó interesante, a la vez que sorprendente, el análisis de los contenidos óseos de las madrigueras. Los zorros suelen transportar a sus madrigueras porciones esqueléticas de las carcasas que están carroñeando, pero este proceso sólo se lleva a cabo durante la época de amamantamiento y cría de los cachorros. También suelen transportar y esconder alimentos para ser ingeridos posteriormente lo cual, finalmente, no siempre ocurre. Sin embargo en las madrigueras junto a los cadáveres sólo encontramos, y muy raramente, los extremos de las patas (metapodios y falanges) y en ningún caso observamos trazas de mordidas claramente visibles.

Esta conducta "extractora" es claramente defensiva, y contribuye a evitar la competencia o riesgos para los cachorros. En algunos casos en los que el presunto riesgo era más elevado (presencia humana muy notoria) los zorros intentaban desplazar trozos muy grandes de carcasas para aumentar la distancia hasta una cincuentena de metros.

A diferencia de lo que ocurre con las aves carroñeras, nunca vimos a un zorro compartir con otro la comida. Cuando se plantea algún problema de competencia se establece una corta refriega que se salda con una actitud de sumisión de uno de los animales que huye a unos cincuenta metros. Allí espera la retirada del dominante para volver sobre la carroña.

Toda esta conducta implica un vector de dispersión a dos niveles: una primera dispersión de sólo algunos metros y una segunda, menos frecuente, de varias decenas de metros.

Zorros y las otras especies

En el caso de las vacas nunca hemos observado dispersiones superiores a los 5 m. Tampoco observamos la pérdida por transporte de elementos esqueléticos ni trazas de dientes sobre los huesos.

En el caso de las ovejas, en cambio, la dispersión era máxima. La secuencia de desarticulación comienza por los miembros delanteros. Estos se encontraban a una distancia media de 13 m con respecto al esqueleto axial. En tres cuartas partes de los casos aparecen marcas de dientes sobre la escápula. Por orden de frecuencia las marcas se presentan sobre las articulaciones proximal del húmero, proximal de ulna/radio y metacarpo proximal (cuando está presente).

La siguiente porción en la secuencia de desarticulación es la cabeza que, a diferencia de lo que se observó en el guanaco, está articulada con el atlas y separada por el axis del resto del cuerpo. Los premaxilares son las partes que presentan más mordiscos.

El tronco es atacado por la zona ventral (dejando mordidos los extremos de las costillas y desapareciendo el esternón) igual que en el guanaco, pero también se observó el ataque desde atrás dejando trazas muy severas en el ilion (y en menor grado en el isquion) y pérdida de las vértebras caudales. Las extremidades posteriores permanecen articuladas a la pelvis incluso hasta después de que el esqueleto axial se desarticule por las vértebras lumbares. La articulación de tibia y fémur es la que presenta mayor daño por mordidas llegando incluso a desaparecer completamente la rótula. El basipodio permanece articulado y frecuentemente es la única zona que conserva la piel.

Estas diferencias se pueden explicar perfectamente por el tamaño diferencial de las tres especies y por la capacidad de los zorros de morder, arrancar y triturar eficazmente los distintos tejidos y huesos.

En el caso de aves carroñeadas o cazadas por los zorros, hemos podido ir siguiendo la degradación del cadáver, en aves de hasta el tamaño de la avutarda (por ejemplo, *Cloephaga*), hasta su total consumición y desaparición.

Zorros y actividades humanas

Durante la campaña de excavación de 1996 se estableció una prolongada interacción entre estos pequeños carnívoros y un campamento humano, en tiendas de campaña dispersas en un bosque. Por ello, tuvimos la ocasión de observar la adaptación de la conducta de esos animales a la presencia humana.

Dentro del área de extensión del campamento había tres cadáveres de guanacos. Sólo uno de ellos, en la periferia, se siguió carroñeando. Sin embargo, ante una actitud no hostil los zorros fueron acortando su distancia crítica que pasó de más de una veintena de metros a apenas dos.

Aunque no se interrumpió el carroñeo sobre la mayor parte de los cadáveres, los zorros eran especialmente atraídos por los residuos y la comida del campamento, llegando a penetrar repetidamente en las carpas de la cocina-almacén aprovechando momentáneas ausencias humanas. Esta atracción

era ejercida en zorros cuya área normal de merodeo distaba más de un kilómetro, y llegó a reunir a media docena de ejemplares.

Conclusiones de tres años de observaciones

En general se produjeron importantes diferencias entre el material depositado en el invierno de 1995 y el material recuperado en el verano de 1998, tanto por cantidad, distribución y disposición como por relación entre materiales. Las ovejas sufrieron importantes modificaciones durante los primeros meses después de la deposición, siendo prácticamente total su abandono pasado el primer año de exposición. Las carcasas de guanacos, en cambio, pueden reactivarse después de un año o más tiempo de producido su abandono temporal por parte de mamíferos carroñeros. No se produjo una degradación a ritmo logarítmico como se preveía sino que la esqueletización y el aprovechamiento por los carroñeros tuvieron ritmos desiguales, dándose tanto casos de procesos rápidos como de procesos con interrupciones notables. La total degradación de tejidos blandos en todos los ejemplares no se produjo hasta pasado el segundo año.

Variables como pisoteo, mordisqueo, entrampe por parte del substrato y enterramiento resultaron ser poco significativas en la variabilidad observada.

La variable más importante en relación con las modificaciones relativas a presencias, dispersión, relaciones espaciales, desarticulación, redeposición y daño morfológico es la actividad de carroñeo por parte del zorro gris, tanto cuantitativa, cualitativa, relacional como espacialmente.

Salvo un par de casos aislados el carroñeo producido sobre la muestra de guanacos durante los primeros seis meses tras la muerte, no tuvo como resultado un daño morfológico de tejidos duros. Es decir, los materiales óseos abandonados definitivamente después de producido el carroñeo inicial no presentaban indicios morfológicos (sí espaciales y disposicionales) de haber sido presa de mamíferos carroñeros y, por tanto, no serían perceptibles arqueológicamente. Así pues, la ausencia de este tipo de trazas en un conjunto arqueofaunístico no implica automáticamente la no incidencia de este tipo de agentes.

La zona más carroñeada fue el morro, seguido del vientre y cráneo-mandíbula (proceso ocurrido en 1995-96). La región pélvica fue carroñeada desde el ano durante el primer año; una vez ausentes los tejidos blandos lo fue (incluso mordisqueada) conjuntamente con la zona lumbar. El carroñeo del tórax y los miembros anteriores fue intenso durante el segundo año (1997), siendo leve durante el tercer año de observación.

FIGURA 2

Cadáver de *Lama guanicoe* perteneciente a la muestra en estudio en 1997. Obsérvese el grado de conservación de los tejidos blandos, el carroñeo en vientre y hocico, aureola bajo la carcasa y falta (desarticulación y transporte) de los miembros derechos. Sobre el lomo excrementos de zorro.

La evolución de las carcasas no resultó uniforme en el caso de los guanacos (Figuras 2 y 3), sí en cambio para el caso de las ovejas. Son escasas las porciones esqueléticas que persisten cercanas al lugar original de deposición para ovejas (Figura 4). En cuanto a los guanacos observamos casos en los que, pasados dos años desde el momento de muerte, se produce un abandono por parte de los mamíferos carroñeros, mientras que para otros cadáveres observamos la máxima transformación del material sólo pasados los dos años desde el momento de muerte, reactivándose la actividad

FIGURA 3

Cadáver de oveja en 1996. Obsérvese el avanzado estado de desmembramiento, en comparación al guanaco de Figura 2 y la desaparición (desarticulación y transporte) de miembros.

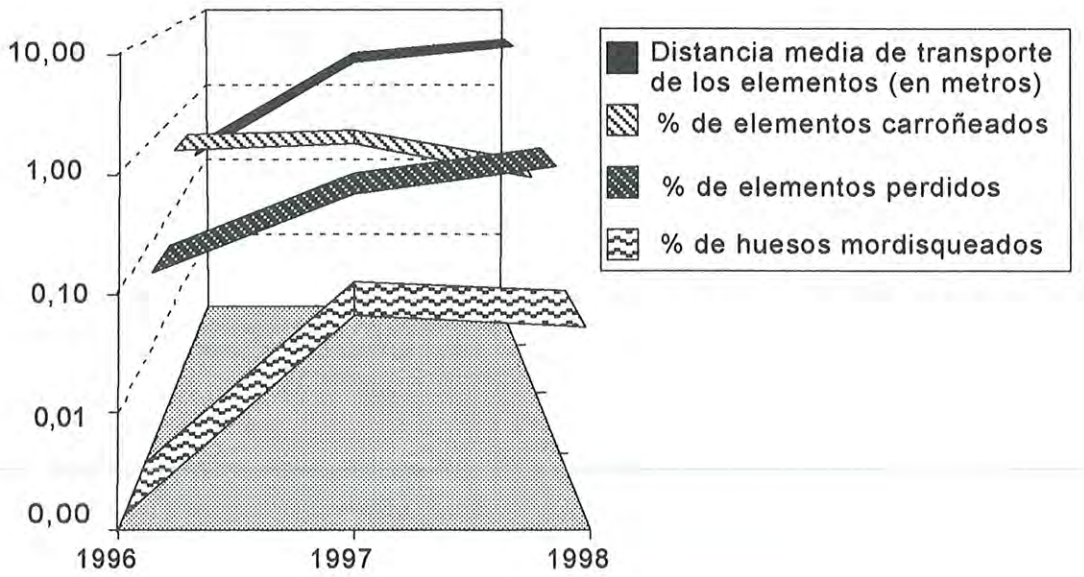

FIGURA 4

Evolución a lo largo de tres años de las variables distancia de transporte, % de elementos carroñeados, % del número de elementos perdidos y % de huesos mordisqueados.

carroñera sobre los restos después de un año de total abandono.

Los huesos de guanaco suelen ser mordisqueados aún después de un largo período de permanencia en superficie. Inicialmente son atacados sólo los tejidos blandos, resultando intactos los elementos óseos en este primer proceso de carroñeo. Una vez eliminados los tejidos blandos suelen ser afectados los tejidos duros, ocasionando esta vez daño morfológico. Este daño es el único factible de identificación en el registro arqueológico.

En ese sentido debemos remarcar que en la muestra de guanacos estudiada no se observan apenas marcas macroscópicas de carroñeo directo sobre los elementos largos del esqueleto apendicular, sí en cambio sobre vértebras, costillas, pelvis y escápulas. Las marcas observadas en costillas se ubican en los extremos distales (porción esternal), nunca proximales (porción vertebral). Contrariamente a lo que se observa en guanaco, los huesos largos de oveja presentan marcas de mordisqueo, tanto en elementos localizados a cielo abierto como en los elementos transportados a madrigueras desde la primera acción carroñera. Las ovejas después de un año de muerte no conservan la integridad de sus partes esqueléticas y apenas algo de lana en el lugar de muerte.

Aunque carcasas de bovinos, ovinos y camélidos son todas carroñeadas por el zorro gris, sólo los huesos de ovinos y camélidos son transportados e incluso introducidos en las madrigueras.

Los elementos de ovinos son mordisqueados y fracturados significativamente tanto a cielo abierto como en cueva. Sin embargo sólo los elementos de guanaco depositados a cielo abierto fueron mordisqueados.

Además de las observaciones estrictamente etológicas y bioestratinómicas de nuestra experiencia pueden extraerse también consideraciones relevantes para la explicación de sitios arqueológicos. Así:

– La actividad carroñeadora de los zorros en los campamentos, que era bien conocida también por los antiguos pobladores "yámana" de la zona, no podemos excluirla en el caso de las comunidades prehistóricas. En los sitios arqueológicos al aire libre no hay que contar tanto con aportes animales naturales sino más bien con sustracción de restos. En ella los pequeños carnívoros pueden haber jugado un importante papel.

– Teniendo en cuenta la destrucción y sustracción selectiva de restos que ejercen, debería ponderarse la acción del zorro sobre los residuos de los asentamientos humanos prehistóricos. Efectivamente, pueden haber hecho desaparecer com-

pletamente restos de animales pequeños o haberse llevado pequeños elementos esqueléticos y dejado, en cambio, restos de animales mayores sin prácticamente trazas de manipulación.

– La acción animal es altamente dependiente de la propia conducta humana. La actitud hostil o indiferente provoca una reacción distinta en estos carroñeros. El abandono momentáneo o la ocupación permanente del campamento puede facilitar o impedir completamente la acción carroñera. La presencia de otros animales como el perro doméstico puede asimismo evitar el carroñeo.

Esto implica que en la interpretación tafonómica de los conjuntos arqueológicos habría que tener en cuenta, también, ese factor humano lo cual conduce a una cierta paradoja, puesto que es precisamente el comportamiento humano el que se quiere conocer a partir de la Arqueología, y por lo que se recurre a la Arqueotafonomía.

La única manera de resolverla será, pues, un análisis que confronte los datos propiamente arqueológicos sobre la conducta humana con otros arqueotafonómicos como las trazas de dientes en huesos carroñeados pero no extraídos del sitio.

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Hunting Reindeer to Support a Marine Economy. An example from Arctic Norway

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ABSTRACT: Substantial semi-subterranean house features from the late Younger Stone Age of Arctic Norway have produced large faunal assemblages which indicate that marine species dominated the diet. Reindeer made up only a small percentage of the recovered bone, but their economic importance was much greater than their role in the diet might suggest. Reindeer bone and antler were extremely important in artifact production, and were used to make most of the fishing and marine mammal hunting equipment crucial in sustaining the primary (marine) economy. It is argued that selection for raw materials including bone, antler and sinew better explains the patterns of reindeer skeletal representation at the site than a dietary model based on maximizing meat returns.

KEYWORDS: NORWAY, STONE AGE, HUNTER-GATHERER, REINDEER, ARTIFACT PRODUCTION

RESUMEN: Ricos depósitos en habitáculos semi-subterráneos procedentes del Paleolítico tardío en la Noruega ártica han generado abundantes muestras faunísticas que evidencian el papel dominante de las especies marinas en la dieta. El reno constituyó una pequeña fracción de los restos recuperados pero la importancia económica de esta especie fue seguramente mucho mayor que lo que pudiera sugerir su papel en la dieta. El hueso y el asta de este cérvido eran extremadamente importantes en la producción de útiles y se utilizaron para fabricar la mayor parte de los equipos de caza y pesca, claves en el mantenimiento de la economía esencialmente marina. Se postula que la selección de materias primas, incluyendo el hueso, el asta y el tendón, ayuda a comprender mejor los patrones de representatividad esquelética del reno en el yacimiento, que lo modelos dietarios simples basados en la optimización del recurso cárnico.

PALABRAS CLAVE: NORUEGA, PALEOLÍTICO, CAZADORES RECOLECTORES, RENO, PRODUCCIÓN DE ÚTILES

INTRODUCTION

The most characteristic feature of the late Younger Stone Age (4200-3800 BP) along the north Norwegian coast are large house depressions or *hustufter*, which are particularly numerous in Varangerfjord (Figure 1). The substantial nature of the houses, known as "Gressbakken houses" after the type site of Gressbakken (Simonsen, 1961, 1963), has given rise to suggestions of permanent or semi-permanent occupation at these sites (Renouf, 1981, 1989; Engelstad, 1984; Schanche, 1994). Many archaeologists argue that these houses were not built by the type of egalitarian society traditionally associated with hunter-gatherers (cf. Lee & DeVore 1968), but rather by a socially stratified group with differences in status and wealth, and perhaps also strictly controlled territories with

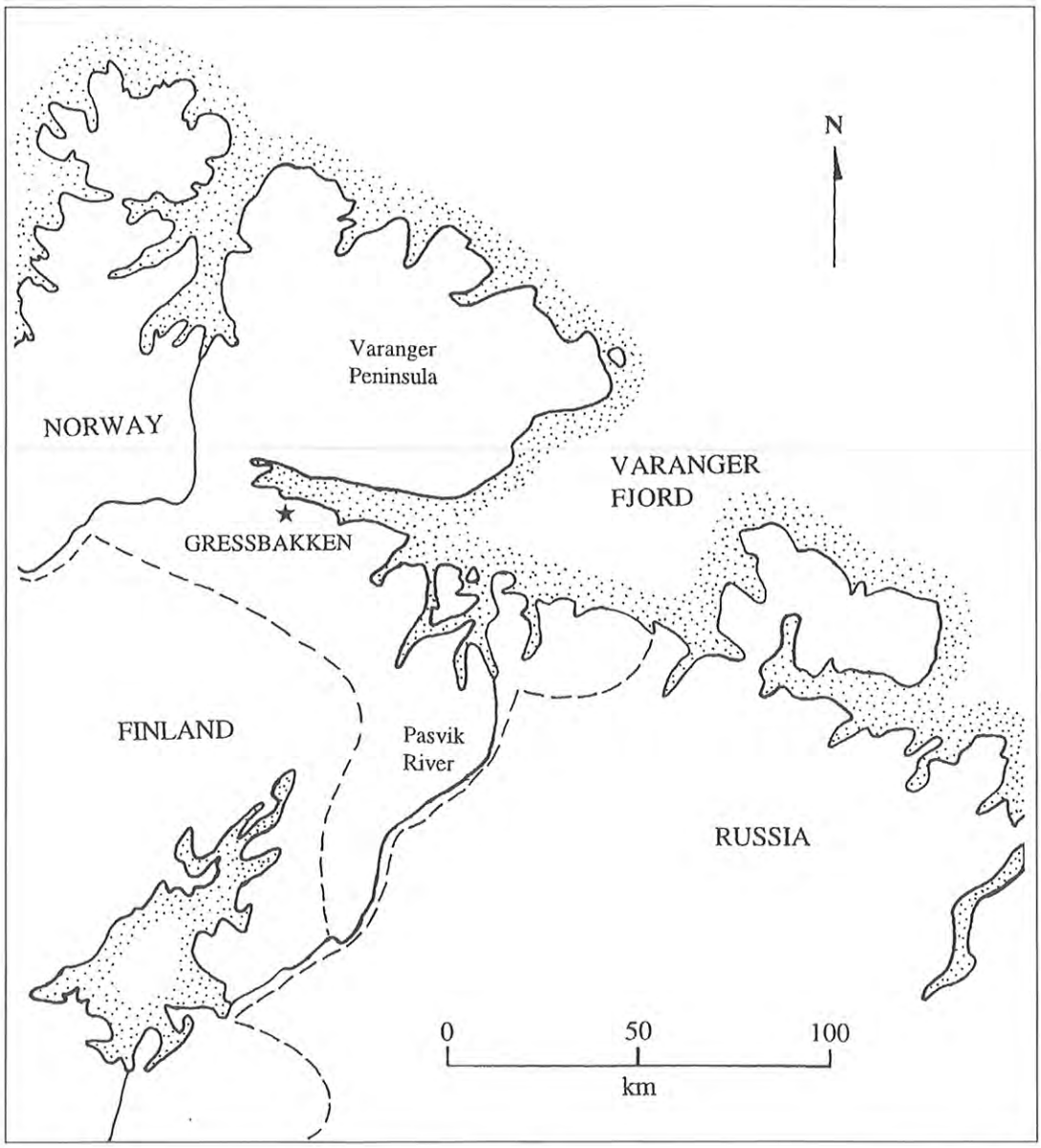

FIGURE 1
Distribution of late Younger Stone Age house depressions in north-eastern Norway and north-western Russia.

differential access to resources (Renouf, 1981, 1989; Myrvoll, 1992; Olsen, 1994; Schanche, 1994).

Gressbakken-type houses are symmetrical and strikingly uniform in construction. They are semi-subterranean with a rectangular floor plan and two rectangular stone-lined hearths along their long-axis (Figure 2). In almost all cases, they are oriented parallel to the contemporary shoreline, with a large midden mound along the side facing the water. This midden is bisected by an entrance passage, and there are often two other entrances, one along each of the short walls, and occasionally a fourth entrance at the rear (Simonsen, 1961; Schan-

che, 1994). The midden deposits consist of a continuous layer of bone and shell, and presumably represent a palimpsest of the activities carried out during the life-span of each house. The longevity of Gressbakken-type houses has been estimated at 30 to 50 years by Knut Helskog (1984) and at 150 years by Kjersti Schanche (1994: 172-177). Schanche wished to demonstrate a sharp increase in population pressure at the end of the Younger Stone Age in order to explain subsequent changes in settlement pattern. She may therefore have over-estimated the lifespan of individual houses.

The faunal assemblages from the site of Gressbakken are the largest among the excavated late Younger Stone Age (YSA) sites in the region. The site was excavated by Povl Simonsen of the Tromsø Museum in 1956 and 1957 (Simonsen, 1961). The deposits were not sieved, but the importance of faunal recovery was stressed to all excavators, and all visible faunal material was hand collected (Simonsen, pers. com.). Bone preservation in the middens was outstanding, and many of the recovered seal bones were intact. While hand collection must have seriously affected the recovery of fish and other small-boned taxa, the sample of larger mammalian taxa such as seal and reindeer is far more representative (Hodgetts, 1999). This article deals with Houses 3 and 4 at the site, where the middens were completely excavated rather than just sampled (Figure 3). House 3 produced a radiocarbon date of 3650 ± 150 BP, and House 4 of 3850 ± 100 BP (Helskog, 1980). The middens contain large amounts of well preserved bone indicating a strong marine focus in the economy (Table 1). All excavated bone material from the site was originally identified by Håkon Olsen, who published an analysis of the fish and bird bones (Olsen, 1967) and was working on the mammalian material when he died (Olsen n.d.). This paper is based on a re-examination of all the mammal bone from Houses 3 and 4 at Gressbakken. The NISP values for fish and birds presented in Table 1 come from Olsen's original notes on file at the Zoological Museum in Bergen, Norway.

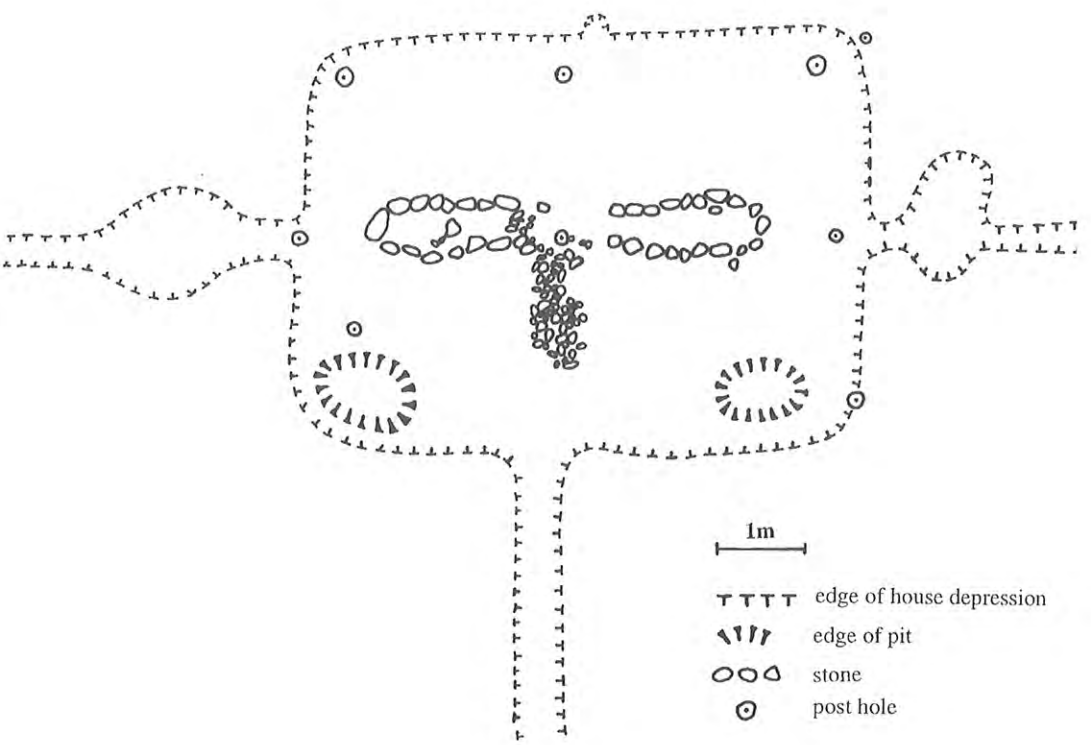

FIGURE 2
Plan of a Gressbakken-type house (after Schanche, 1994: Figure 14).

Taxon	Common Name	House 3 NISP	House 3 %	House 4 NISP	House 4 %
Gadus morhua	Cod	1275	31.1	11514	61.4
Pollachius virens	Coalfish or Pollack	158	3.9	1100	5.9
Melanogrammus aeglefinus	Haddock	186	4.5	1118	6.0
Molva molva	Ling	34	0.8	148	0.8
Other fish		6	0.1	87	0.5
TOTAL FISH		**1659**	**40.5**	**13967**	**74.5**
Uria aalge/Uria lomvia	Guillemot/Brunnich's murre	336	8.2	2021	10.8
Fratercula arctica	Puffin	17	0.4	72	0.4
Plautus alle	Little auk	17	0.4	59	0.3
Larus marinus	Greater black back gull	38	0.9	16	0.09
Fulmaris glacialis	Fulmar	20	0.5	27	0.1
Somateria mollissima/S. spectabilis	Common eider/King eider	53	1.3	35	0.2
Lagopus lagopus	Willow grouse	158	3.9	75	0.4
Other bird		35	0.8	54	0.3
Unidentified bird		49	0.9	580	3.1
TOTAL BIRD		**674**	**16.4**	**2359**	**12.6**
Phocidae	Seal family	823	20.1	1450	7.7
Phoca groenlandica	Harp seal	279	6.8	287	1.5
Phoca hispida	Ringed seal	55	1.3	109	0.6
Phoca vitulina	Harbor or Common seal	30	0.7	22	0.1
Erignathus barbatus	Bearded seal	23	0.6	42	0.2
Other seal		4	0.1	7	0.04
Cetacea	Whale family	18	0.4	58	0.3
Phocaena phocaena	Harbor porpoise	5	0.1	16	0.09
Lagenorhynchus sp.	Dolphin	112	2.7	73	0.4
Globicephalus melaena	Pilot whale	7	0.2	5	0.03
Other whale		7	0.2	2	0.01
TOTAL SEA MAMMAL		**1363**	**33.3**	**2071**	**11.0**
Rangifer tarandus	Reindeer	190	4.6	231	1.2
Canis familiaris	Dog	74	1.8	18	0.1
Canis lupus	Wolf	43	1.0	3	0.02
Vulpes vulpes	Fox	52	1.3	23	0.1
Martes martes	Pine martin	5	0.1	18	0.1
Ursus arctos	Brown bear	9	0.2	1	0.01
Castor fiber	Beaver	20	0.5	43	0.2
Other land mammal		10	0.2	4	0.02
TOTAL LAND MAMMAL		**403**	**9.8**	**341**	**1.8**
SUM TOTAL		**4099**		**18747**	

note: NISP values do not include ribs, vertebrae or antler because of the likelihood of counting multiple fragments from a single specimen.

TABLE I

Representation of animal taxa in the middens at Gressbakken Houses 3 and 4 (bird and fish values after Olsen, n.d.).

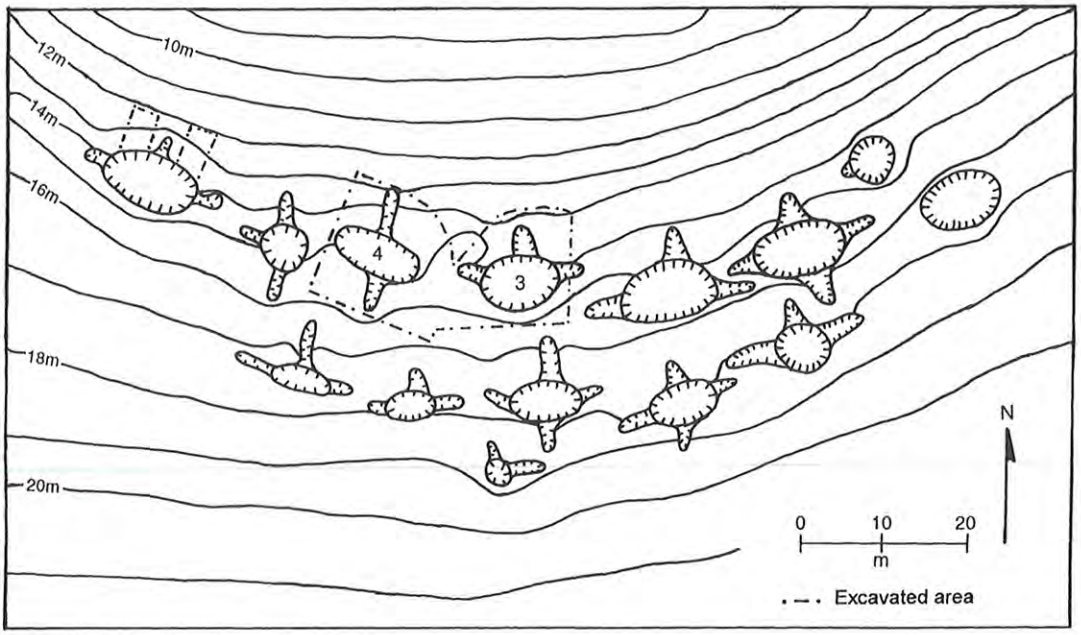

FIGURE 3
Late Younger Stone Age house features at Gressbakken, Varangerfjord (after Simonsen, 1961: Figure 111).

Fish, particularly cod, are very well represented at both Houses 3 and 4, as are sea birds and sea mammals such as harp seal and ringed seal, and to a lesser extent small whales. The large numbers of fish at House 4 overwhelm all other taxa. Fish form a smaller proportion of the assemblage at House 3, but the relative importance of various fish, bird and mammal species is much the same as at both houses. The only terrestrial mammal present in any quantity is reindeer, which accounts for 10.8% of all identified mammal remains at House 3 and 9.6% at House 4. However, the small amounts of excavated reindeer bone do not reflect the real importance of the animal at the site given the large number of artifacts constructed using reindeer bone and antler.

REINDEER AS A FOOD SOURCE

Reindeer, though the most important terrestrial mammal at most of the Varanger sites, does not occur in large numbers. This suggests that unlike fish and sea mammals, reindeer did not make a major contribution to the diet. There is a strong correlation (r_s=0.76, P<0.001) between the reindeer element distributions at Houses 3 and 4 at Gressbakken. However, the results from House 4 must be viewed with some caution since the reindeer sample is small (MAU=58), and may not be as representative as the larger one from House 3 (MAU=100). The two houses have very different values for distal humerus and proximal radius, but the remainder of the distribution plots are strikingly similar (Figure 4). Axial elements are scarce, as are proximal humerus, distal metacarpus, pelvis and both proximal and distal femur.

This trend appears to be partly attributable to density-mediated destructive processes. There are currently no bone mineral density measurements available for reindeer, but the values recorded by Lyman (1984) for the deer skeleton[1] will give a good approximation, given the similar anatomical structure of the two animals. The bone mineral density values used in this analysis are for the part of each element which occurred in the largest

[1] Lyman (1984) derived his deer bone mineral density values using photon absorptiometry measurements on black-tailed deer (*Odocoileus hemionus columbianus*), mule deer (*Odocoileus hemionus hemionus*) and white-tailed deer (*Odocoileus virginianus leucurus*).

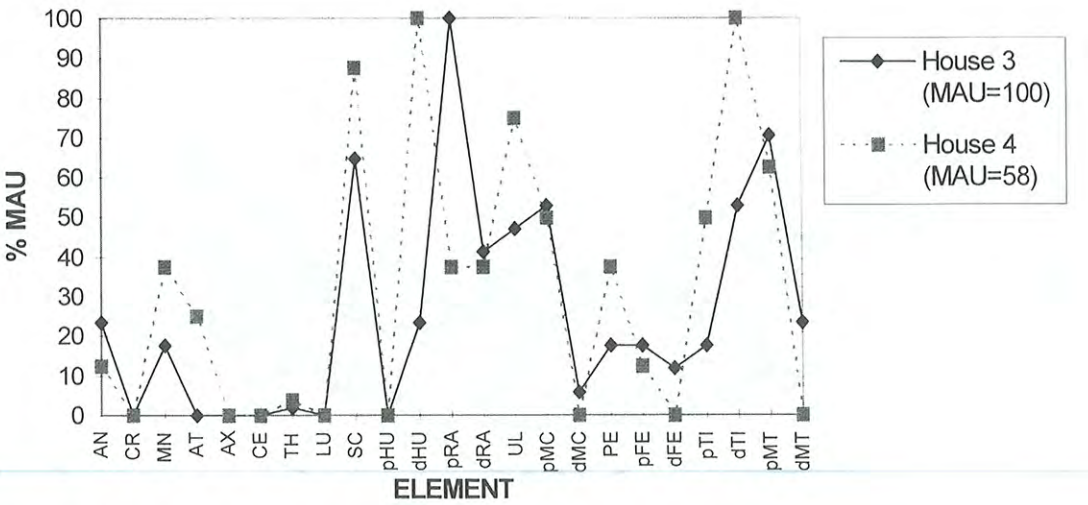

FIGURE 4

Reindeer body part representation at Gressbakken Houses 3 and 4.
abbreviations: p=proximal, d=distal, AT=atlas, AX=axis, CE=cervical, TH=thoracic, LU=lumbar, SC=scapula, HU=humerus, RA=radius, UL=ulna, MC=metacarpus, PE=pelvis, FE=femur, TI=tibia, MT=metatarsus.

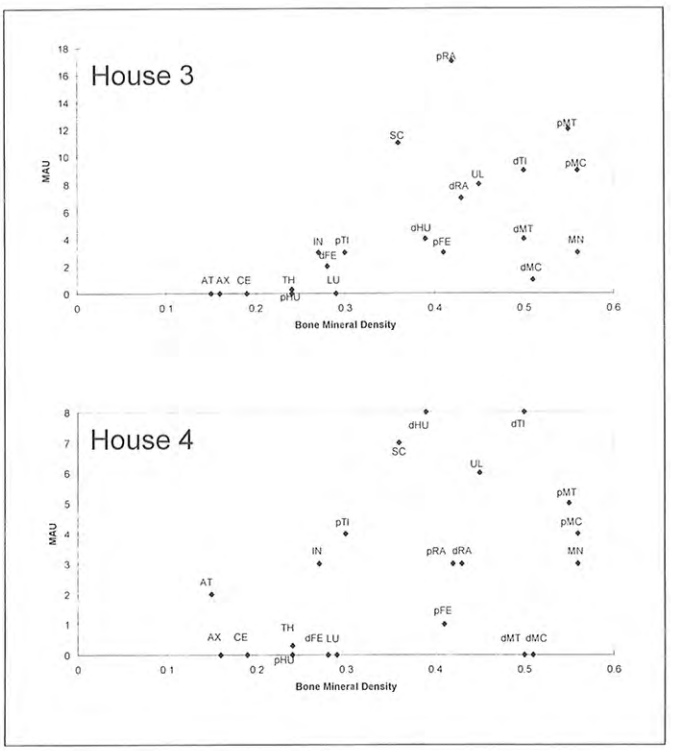

FIGURE 5

Reindeer element frequency vs. deer bone mineral density at Gressbakken Houses 3 and 4 (House 3: r_s=0.64, P=0.004; House 4: r_s=0.44, P=0.04).

numbers and was thus used to derive MAU (e.g. the glenoid region of the scapula).

Dense parts of the skeleton tend to be well represented in the middens. Proximal metapodia and distal tibiae, some of the densest bones in the artiodactyl skeleton, are among the best represented at both houses (Figure 5). At House 3, there is a fairly strong positive correlation (r_s=0.64, P=0.004) between bone mineral density and reindeer element representation, with a weaker positive correlation at House 4 (r_s=0.44, P=0.04). Both dogs and wolves are present in the identified material from Gressbakken, and there is some evidence of carnivore gnawing on the reindeer bones in the assemblage. Their impact along with natural decomposition probably accounts for the correlations between bone mineral density and MAU for reindeer elements. However, there are features of the body part distributions which cannot be satisfactorily explained by differential preservation, such as the high numbers of scapulae and low numbers of proximal femora, two elements with similar bone mineral densities.

Meat utility indices are traditionally used to asses the impact of human transport of carcass parts on a bone assemblage (Binford, 1978; Speth, 1983; Legge & Rowley-Conwy, 1988; Lyman *et al.*, 1992). Binford (1978) developed a meat utility index (MUI) for caribou based on the quantity of meat associated with each part of the skeleton[2]. There is no clear linear association between this index and reindeer MAU at Gressbakken Houses 3 and 4 (Figure 6), but the plots resemble the L-shaped curve typical of a "reverse utility strategy". Such scatterplots generally indicate kill sites, where the higher utility elements have been removed to a residential camp elsewhere (Binford, 1978).

The substantial house remains and thick midden deposits at Gressbakken speak of an intensely occupied base camp, not a short term hunting camp, so the presence of a reverse utility strategy of carcass transport does not agree with Binford's

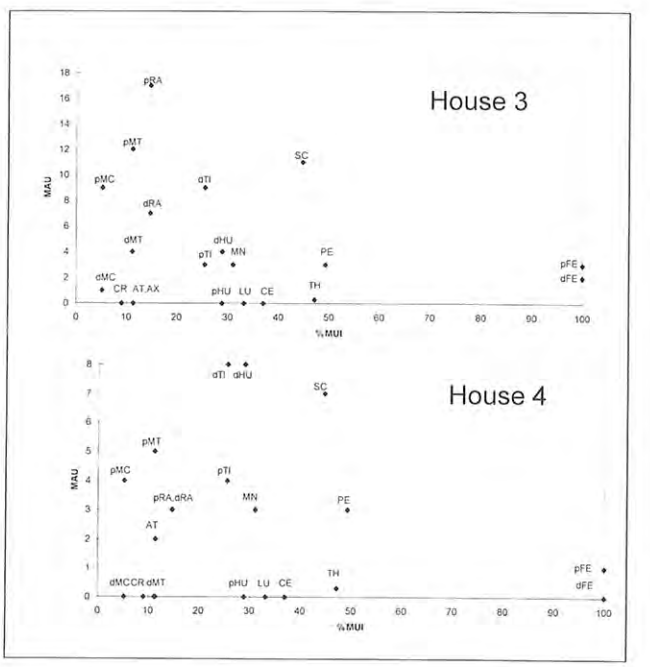

FIGURE 6

Reindeer element frequency vs. MUI at Gressbakken Houses 3 and 4 (House 3: r_s=-0.35, P=0.06; House 4: r_s=-0.07, P=0.38).

[2] "Caribou" and "reindeer" are the common names for regional populations of the species *Rangifer tarandus*. "Caribou" refers to the population in northern North America and Greenland, "reindeer" to that in northern Scandinavia and Russia (Burch, 1972). Binford's caribou indices are therefore fully applicable to reindeer.

	Taxon and Element	HOUSE 3	HOUSE 4
SEA	WHALE (*Cetacea*)		
	vertebra	0	1
	rib	0	1
	TOTAL WHALE	**0**	**2**
	DOLPHIN (*Lagenorhynchus sp.*)		
	rib	**1**	**0**
	SEAL (*Phocidae*)		
	canine tooth	1	1
	baculum	1	0
	TOTAL SEAL	**2**	**1**
AIR	BIRD		
	longbone	**35**	**26**
LAND	BEAVER (*Castor fiber*)		
	incisor	**3**	**1**
	CARNIVORE		
	canine tooth	**2**	**1**
	REINDEER (*Rangifer tarandus*)		
	antler	110	79
	tooth	0	1
	thoracic	0	1
	scapula	3	8
	humerus	0	1
	radius	3	0
	ulna	7	4
	calcaneus	1	0
	metapodial	0	2
	TOTAL REINDEER	**124**	**96**
	REINDEER (*R. tarandus*) or ELK (*Alces alces*)		
	antler	**82**	**65**
	LARGE TERRESTRIAL MAMMAL (probably reindeer)		
	rib	2	2
	scapula	2	4
	longbone	75	56
	TOTAL LTM	**79**	**62**
	UNKNOWN		
	bone or antler	22	31
	TOTAL	**312**	**255**

TABLE 2

Raw material selection for bone and antler artifacts at Gressbakken Houses 3 and 4 (counts of numbers of artifacts and artifact fragments).

(1978) model. This lack of fit may relate to the major underlying assumption of meat and other utility curves; that animals were hunted primarily as a source of food (but see Savelle, 1997). The small numbers of reindeer bones in the Varanger assemblages indicate that reindeer did not play a major role in the diet. Yet reindeer bone and antler dominate among the artifact assemblages, suggesting an importance for reindeer not indicated by the species lists. The inhabitants of Gressbakken may have consumed much of the reindeer meat at the kill site, returning to the base camp with bones and antler valued as raw material.

ARTIFACTS OF BONE AND ANTLER

One of the characteristic features of the terminal Younger Stone Age assemblages from Varanger is the large number and wide variety of bone and antler artifacts (Simonsen, 1961; Renouf, 1989; Olsen, 1994; Schanche, 1994). Antler is particularly prominent in the artifact assemblage, as are reindeer longbones (Table 2). Some of the unworked antler burrs found on the site had been shed naturally, suggesting that antler was collected specifically as a raw material as well as coming to the site attached to carcasses.

Table 2 lists the raw materials used to produce the bone and antler artifacts at Houses 3 and 4. It reveals a striking difference in the use of land and sea mammal bone, completely reversing the relative importance of the two classes indicated by the unworked bone assemblage. The top part of the table shows sea mammals which are represented by only very small numbers of artifacts, mainly harp and ringed seal canine tooth beads. Birds are better represented among the artifacts, primarily in the form of long bone segments which were scored and snapped at both ends to make beads or tubes.

Land mammals make up the lower portion of the table, and the bulk of the assemblage. A single bear tooth pendant, several fragments of unidentifiable carnivore (wolf?) tooth pendants, and several beaver incisors worked to form cutting edges were found, as was a single piece of elk antler which had been scored and snapped as part of the early stages of artifact manufacture. The remainder of the artifacts, most of them functional tools such as fish hooks, harpoons and scrapers, are constructed using reindeer antler (or antler which

Bird	Sea Mammal	Land Mammal	
Bone	Bone	Bone	Antler
30 beads	5 canine tooth beads	61 polished/abraded	159 scored &
29 needles	3 incised decoration	48 points	snapped
10 points	1 scored & snapped	36 chisels	27 fish hooks
6 polished/abraded	1 abraded	22 incised decoration	25 barbs
5 tubes	1 object of unknown	9 scrapers	22 harpoons
3 buttons?	function	6 awls	22 combs
		6 daggers	19 leister prongs
		4 leister prongs	19 points
		4 incisor tooth	8 daggers
		knives	8 abraded
		3 harpoons	7 chisels
		2 canine tooth beads	5 awls
		1 net weight	3 decorated
		1 fish hook	2 U-shaped objects
		1 barb	1 T-shaped object
		1 comb	1 animal figure
		1 cylinder	
		1 animal figure	

TABLE 3

Artifact types made of bird, sea mammal, and land mammal bone at Gressbakken Houses 3 and 4 combined.

could not be positively identified but is probably reindeer) and reindeer (or reindeer-sized land mammal which is almost certainly reindeer) bone.

The representation of various species among the unworked bone indicates that the main economic activities taking place on the site were fishing and sealing, and the artifact inventory (Simonsen, 1961) supports this conclusion. Among the bone and antler artifact types (Table 3), fish hooks, leister prongs, net sinkers, loose barbs and harpoons can be reliably attributed to fishing and sea mammal hunting. Scrapers and needles would have been used for working hides, chisels for woodworking. Combs and beads would presumably have been used for personal ornamentation. Bone points, daggers and "t-shaped artifacts" are more difficult to assign to specific functions. Thus, the vast majority of the fishing and marine mammal hunting equipment found at the site is produced using reindeer bone and antler. Marine mammal bone, on the other hand, is rarely worked and tends to be used for decorative rather than functional items.

DISCUSSION

The two elements of the reindeer skeleton which are best represented in the artifact assemblage, scapula and ulna, are also over-represented among the unworked reindeer elements at Houses 3 and 4 at Gressbakken. The moderate positive correlation that exists between bone mineral density and reindeer skeletal element representation suggests that post-depositional destructive factors have shaped the unworked reindeer assemblage. However, neither scapula or ulna is among the elements with highest bone mineral densities. Of the twenty-one elements compared in Figures 4 through 6, scapula ranks tenth and ulna ranks fifteenth. The correlation between the best represented elements among the artifacts and among the unworked material holds at both houses and suggests, if somewhat tentatively, that reindeer bones favored in artifact manufacture were preferentially selected for return to the base camp. Whether or not this selection occurred, the importance of land mammal bone in supporting the marine economy cannot be denied. This importance could not have been detected by considering the faunal material in isolation and only became apparent when the worked bone material was also included in the analysis.

The selection of reindeer antler and bone for artifact production probably occurred for practical reasons. Antler is strong and easy to work, and several artifacts could be produced using a single antler. Reindeer longbones are longer, straighter, and have a thicker cortex than those of seals, making them better suited to tool manufacture. Reindeer would also have been valued for their long sinews and their hides, which were doubtless important for clothing and bedding and perhaps also for temporary shelters and skin boats. The seal bones on the site represent large quantities of meat and fat, given that an adult harp seal averages 150 kg, and an adult ringed seal averages 87 kg. Fish were also widely available and were obviously intensively exploited. There was thus no shortage of food at the site, a suggestion borne out by the very limited degree to which both land and sea mammal bones were processed for marrow[3]. Given the abundance of marine food, it seems both reasonable and probable that non-food uses dictated which parts of the reindeer carcass were returned to the site.

While reindeer meat may have been an important part of the diet at certain times of the year during hunting trips away from the base camp, it was not consumed in large quantities at the site of Gressbakken itself. Meat value was apparently of little concern in determining which elements of the reindeer carcass were transported to the site, as evidenced by the paucity of such important meat bearing elements such as femur. Instead, elements favored for artifact manufacture, such as scapula and ulna, may have been selected for return to the site.

It perhaps reflects an essential balance between land and sea that the late Younger Stone Age inha-

[3] The seal bones were probably not processed for marrow due to their structure. Seals lack the distinct marrow cavity found in terrestrial mammal bones. Their medulary cavities are filled instead with trabeculated bone, and any digestible organic matter is dispersed throughout the entire bone (Cruz-Uribe & Klein, 1994: 40; Lyman *et al.*, 1992: 537). Occasionally, reindeer longbones at the site had their epiphyses removed so that the marrow could be removed from the diaphysis (which was then left as a hollow tube), but there was no indication of intensive processing for marrow and grease which would be expected if the community was under dietary stress (cf. Outram 1988).

bitants of Varanger had to look inland for raw materials in order to maintain the marine focus of their economy. Reindeer antler was obviously the preferred material for making fish hooks and harpoons. Antler was traditionally prized for its strength and was used almost to the exclusion of bone in tool production among many northern hunter-gatherers (Grønnow *et al.*, 1983). Activities such as collecting shed reindeer antlers from the ground and hunting reindeer were an essential part of fishing and sea mammal hunting. The latter activities were dependent on the raw materials provided by the former. Reindeer must have had a special place in the lives and thoughts of the people who lived at Gressbakken, and an importance belied by the small numbers of reindeer bones deposited in the middens.

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Archaic Fishing at Quebrada de los Burros, Southern Coast of Peru. Reconstruction of Fish Size by using Otoliths

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ABSTRACT: This paper gives a preliminary survey of the fish fauna excavated at the Archaic site Quebrada de los Burros, on the southern coast of Peru. The most abundant fish remains are from sciaenids. Reconstruction of body length and weight are made for *Sciaena deliciosa*, and mean sizes of that fish are given for the third level of the excavation dated 7735 ± 45 BP. Probable fish catching methods are nets and hook and line, both used offshore and from sand beaches of the coast.

KEYWORDS: ARCHAEOICHTHYOLOGY, ARCHAIC, OTOLITH, SCIAENIDAE, SOUTHERN PERU

RESUMEN: En este artículo se presenta una visión preliminar de la ictiofauna excavada en el sitio Quebrada de los Burros, en la costa sur del Perú. Los restos más abundantes son los de esciénidos. Se describe la reconstrucción de la longitud total y del peso para *Sciaena deliciosa*, y se calcula su tamaño medio en el nivel tres de la excavación con fechas límites 7735 ± 40 y 7195 ± 45 AP. Probablemente se pescaron con redes y líneas con anzuelos, tanto desde playas arenosas como mar adentro.

PALABRAS CLAVE: ARQUEOICTIOLOGÍA, ARCAICO, OTOLITO, SCIAENIDAE, PERÚ SUR

INTRODUCTION

Until recently, early and middle Archaic periods along the far south Peruvian coast were poorly documented (Sandweiss *et al.*, 1998; Lavallée *et al.*, 1999a, b), and the importance of marine subsistence resources was still being debated. Even though that part of the coast is covered by an extremely arid desert, the Pacific Ocean in front of it is one of the most productive ecosystems of the world. Despite this fact, very little solid archaeofaunal analysis has been carried out up to date (see E. Reitz in Sandweiss *et al.*, 1989; Wise, 1990). Since 1996, the author has been collaborating with the French Archaeological Mission under the direction of Danièle Lavallée and the first results are being published (Lavallée *et al.*, 1999a, b).

DESCRIPTION OF SITE AND METHODS

Quebrada de los Burros (QLB) is located in the southernmost department of Peru (Tacna) at 18' S, about forty kilometers north of the Chilean boundary. This small canyon, perpendicular to the coast line, slopes rather steeply: the excavation itself is 200 meters above sea level but only 1,5 kilometers from the seashore. Although the bottom of the Quebrada keeps wet almost all year long, the surrounding area is completely arid, except during strong El Niño events.

Taxa	NISP		MNI	
	#	%	#	%
Chondrichthyes	6	0,34	5	0,84
Engraulidae	54	3,05	5	0,84
Ethmidium maculatum	98	5,53	38	6,38
Sardinops sagax	48	2,71	24	4,03
Galeichthys peruvianus	20	1,13	11	1,85
Paralabrax humeralis	17	0,96	6	1,01
Trachurus murphyi	251	14,16	74	12,42
Anisotremus scapularis	19	1,07	14	2,35
Isacia conceptionis	87	4,91	46	7,72
Cheilotrema fasciatum	2	0,11	2	0,34
Cilus gilberti	58	3,27	50	8,39
Sciaena spp.	920	51,89	238	39,93
Girella laevifrons	2	0,11	1	0,17
Aplodactylus punctatus	2	0,11	2	0,34
Chirodactylus variegatus	49	2,76	34	5,70
Labrisomus philippii	1	0,06	1	0,17
Scartichthys sp.	1	0,06	1	0,17
Katsuwonus pelamis	1	0,06	1	0,17
Sarda chiliensis	73	4,12	28	4,70
Scomber japonicus	64	3,61	15	2,52
TOTAL	1773	100	596	100

TABLE 1

Species list for level 3. NISP and MNI estimates by taxon.

The main excavation consists of a broad horizontal area worked by successive "décapages". It brought to light several occupation levels, with hearths, abundant lithic tools, marine shells concentrations (*Concholepas concholepas*, *Mesodesma donacium*, *Fissurella spp.*, etc.) and many fish remains. The sample from which the analysis is presented here consists of the material recovered from 29 m^2 of level 3 of the 1997 excavation, using a 1/8" mesh screen.

The occupation of QLB took place between 9800 and 3200 BP, but radiocarbon dating on marine shells gave 7735 ± 40 (Gif-11004) and 7195 ± 45 BP (Gif-11002) as limits for the third level. For more details, see Lavallée *et al.* (1999a, b).

The identifications were carried out by the author using his own comparative skeletal collection rich of about 500 specimens from the South American Pacific. Of these more than 130 specimens are typical marine Peruvian fishes. NISP and MNI have both been used and estimated for each square meter by means of counts and symmetry or size criteria.

For constructing the model, 38 pairs of otoliths (*sagittae*) of *Sciaena deliciosa* (Tschudi, 1846), the most common Sciaenidae from central and southern Peru, ranging from 174 mm TL (62 g) to 490 mm TL (1125 g) and collected through the year, have been used. Dimensions (length, height and thickness) were measured with a resolution of 0,01 mm, and weights with a 0,01 g resolution. The relationship between otolith length or weight and body length or weight is described by the allometric equation (Le Cren, 1951; Reitz & Cordier, 1983):

$$Y = a\,X^b$$

where Y and X are the parameters we want to connect, *a* is a constant and *b* the exponent fluctuating around 1 if the parameters are of the same dimension (either lengths or weights), around 3 if one of the parameters is a length and the other a weight.

RESULTS

The site ichthyofauna

Over several thousands of fish remains, in a bad state of preservation, have been collected from each level. For the 3rd level, 20 taxa have been identified and the NISP is 1773 for a MNI of 596 (Table 1). Sciaenids are the best represented with a mean proportion of 55,3%. Second come the carangids with 14,2% and then scombrids, clupeids and haemulids oscillating between 8,2% and 6%.

The majority of the identified species belong to sand bottom or open sea biotopes (Figure 1). Even if we consider that sciaenids and carangids proportions are exaggerated because of the better preservation of some of their skeletal elements - otoliths and/or hyperostotic bones - rock bottom fishes are obviously very rarely represented. Typical rockfishes such as *Aplodactylus punctatus*, *Labrisomus philippii*, *Scartichthys gigas* or *S. viridis* are almost completely absent. Such a faunal list suggests that archaic fishermen from QLB were mostly prospecting sand beaches for fishing and were able to cross the sandbank and enter the open sea with some kind of raft. The scombrids, at least, could not be caught from the seashore. Fish catching methods were probably hook and line and nets.

The otolithometric model

Otoliths have often been used for size estimation (Witt, 1960; Casteel, 1976) but in most cases the parameter measured on the otolith was its length. It seems that recently the interest of fishery biologists in the relationship between otolith weight and the age of fish has increased (cf. Second International Symposium on Fish Otolith Research and Application, Bergen, Norway, 20-25 June 1998).

Our measurements on 38 pairs of otoliths of *Sciaena deliciosa* reveal several characteristics of that species:

– length, thickness and weight of right and left otoliths are not statistically different ($p<0,001$), so both sides can be used and joined for live fish size estimation; paradoxically, height of right sagitta is superior to the one of left sagitta in our sample (unilateral test);

– the otoliths grow slower than the rest of the body (SL or TL), the exponent of the allometric equation being superior to 1;

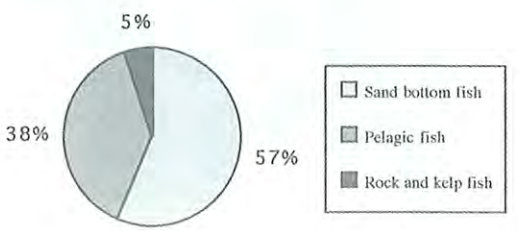

FIGURE 1
Proportions of fish remains (NISP) within each ecological group.

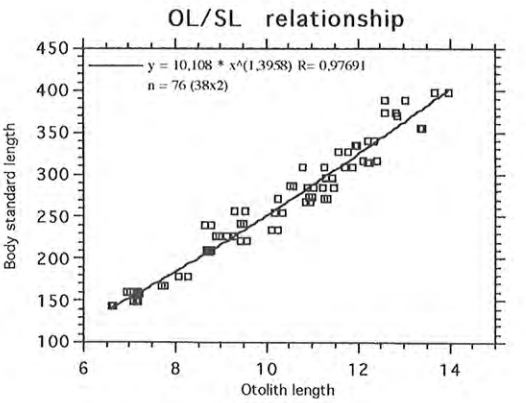

FIGURE 2
Relationship between otolith length and standard length.

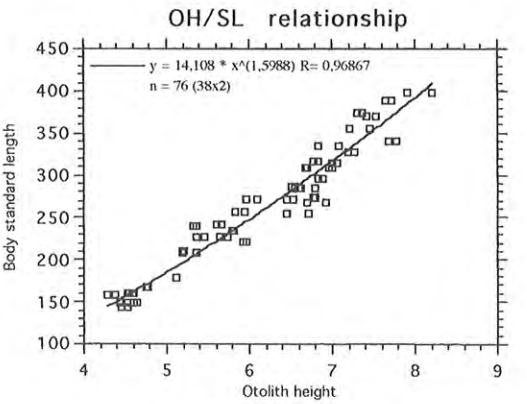

FIGURE 3
Relationship between otolith height and standard length.

– the length and height of otoliths are closely connected to body length or weight of fish (Figures 2 & 3);

– the weight of otolith is closely connected to body length (Figure 4) but moderately so to body weight (R = 0,89);

- the thickness of otoliths is not reliable, as it is poorly correlated to body length (R≤0,7); it could be due to the not well defined shape of the bump growing with age on the outer face of the sagitta;

- the reconstruction of standard length for the set of otoliths by using the model established and the parameters length, height or weight from each otolith gives three series of very similar results which are not statistically different (p<0,001).

The body weight can be predicted from the body length thanks to the relationship given in Figure 5.

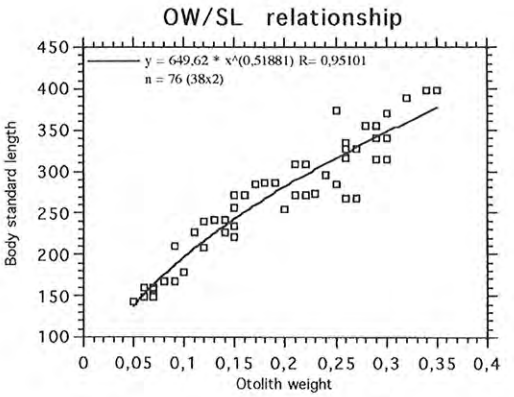

FIGURE 4

Relationship between otolith weight and standard length.

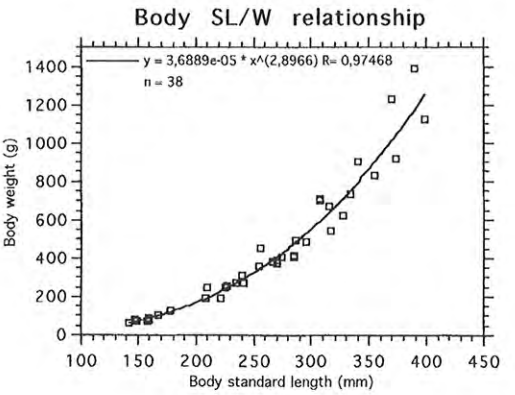

FIGURE 5

Relationship between body weight and standard length.

The reconstruction of live "lorna" size from otoliths' weight

Only complete otoliths (*sagittae*) of "lorna", *Sciaena deliciosa*, have been used for the estimations of size (Figure 6), broken ones have been discarded as their total weight would not be representative. In fact, complete otoliths represent 75,6% in number, and 78,2% in MNI, of all the otoliths found in level 3, i. e. 75,6% of 332 = 251 with a MNI of 176.

Each otolith has been weighed and the corresponding live size has been calculated using the model established. Calculations have been made separately for right and left otoliths. The 110 right otoliths gave a mean SL of 236 mm; the 141 left otoliths gave a mean SL of 242 mm (We have no explanation for the dominance of left otoliths). Intuitively, the value we should obtain using the MNI (176) for that kind of calculation would be between those two means, and, in fact, the value is 239 mm. As we were looking for an easy and rapid method to obtain a reliable estimation of the mean size of the lornas captured and as both mean SLs obtained were very close in that case, we pooled right and left data. We found that the mean length of the "lornas" involved is 240 mm (corresponding TL is 296 mm) and the mean weight is 289 g. Minimal and maximal standard lengths are 137 mm and 388 mm. The size frequency diagram is given in Figure 7.

In order to examine the validity of the model and the diagenesis and possible loss of weight of

FIGURE 6

Otoliths of *Sciaena deliciosa* from square meter C5 of the level 3 of QLB.

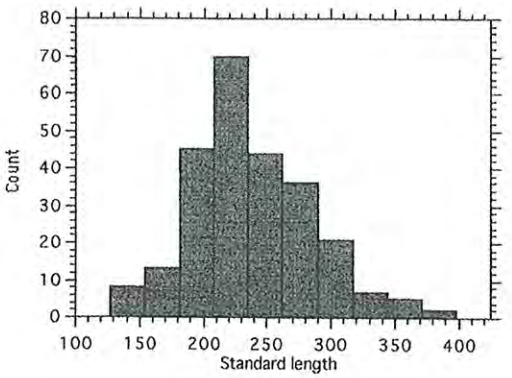

FIGURE 7

Size frequency diagram of lorna (*Sciaena deliciosa*) from level 3 of QLB.

the otoliths, the length of all the 251 otoliths has also been measured. The mean standard length obtained in this way is of 237 mm. This value is slightly, but not statistically ($p<0,001$), different than the one obtained by using weights, which is 240 mm, and does not change the result much. It shows that the model gives similar estimates using either parameter and that, in our case, otoliths have not lost weight through diagenesis processes, or if they have, this is balanced by an abrasion and/or small perimetral chips affecting the length measurement. In fact, diagenesis could affect the organic part (mainly protein) of the otolith which generally fluctuates between 0,2% and 10% of the total weight (Degens *et al.*, 1969), but we do not know its exact value for *Sciaena deliciosa*.

DISCUSSION

Very little zooarchaeological data exists for the archaic period of southern Peru. Sandweiss *et al.* (1998) briefly mention a modal standard length of 172 mm, obtained for the genus *Sciaena* and calculated from 534 otoliths. The modes are not easy to compare but our results give a mode of 220 mm, which is significantly higher. Hence, the people from QLB were fishing bigger "lornas" than those from Quebrada Jaguay situated about 300 km north-west and 2 to 3 thousand years older. Such fact seems surprising but could relate to the biotope exploited.

The wide range of sizes, with a low coefficient of variation (19,5%), obtained here (Figure 7) lead us to believe that lornas were caught with nets instead of hook and line. The shape of the curve could reflect the selectivity of the fishing gear, gillnet or hook, or a seasonal exploitation corresponding to a given size-class. Further investigations will try to address that question.

The mean weight of lornas' otoliths from the third level is of 0,15 g. If we apply the model equation for this value, we obtain a mean standard length of 244 mm, which is 4 mm higher than the one calculated before, working out the average of the standard lengths obtained from each otolith separately. The difference is due to the level of precision used for the calculations. In fact, this represents only a 1,6 % error, which in our opinion is acceptable with regard to the saving in time. By weighing a batch of selected complete otoliths from a given square meter and then dividing the result by the number of otoliths, and applying the equation, one can rapidly obtain a good idea of the mean weight of the sciaenids involved through their otoliths. High numbers of otoliths allow for this approximation without using the MNI which is always difficult to manipulate. Note that if one wants to obtain the total volume of edible meat and then the yield of protein, one must in that case multiply the mean weight by the adequate coefficient - 50% of edible meat which contains 18,5% of protein (IMARPE/ITP, 1996) - and then by the MNI estimate[1].

CONCLUSION

Otoliths are the most numerous anatomical elements and among the best preserved, not only in our site, but in several other southern peruvian sites (Sandweiss *et al.*, 1989; Sandweiss *et al.*, 1998). For such reason, they constitute appropiate material for live fish size reconstruction. Otoliths are easy to get from fresh sciaenids and once the relationship between otolith weight and total body weight has been established, it becomes easy to reconstruct the mean weight of the "lornas" caught during archaeological times in Peru and north Chile.

[1] Mean weight: 289 g. Edible meat: 145 g. Protein: 27 g. MNI = 176.
Total weight: 50,8 kg. Total edible meat: 25,4 kg. Total protein yield: 4,7 kg.

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Revision zum Vorkommen des *Equus (Asinus) hydruntinus* (Regalia 1907) im Chalkolithikum der Iberischen Halbinsel

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ZUSAMMENFASSUNG: Die ^{14}C-Datierung einer angeblich vom Europäischen Wildesel, *Equus (Asinus) hydruntinus* stammenden Phalanx 1 vom Cerro de la Virgen/Provinz Granada, datierte den Fund in das frühe Mittelalter. Damit kann die aufgrand von verschiedenen Knochenfunden aus dem Süden der Iberischen Halbinsel postulierte Existenz des Europäischen Wildesels im 3. vorchristlichen Jahrtausend nicht mehr aufrecht erhalten werden

SCHLÜSSELWÖRTER: WILDESEL, *EQUUS HYDRUNTINUS,* CHALKOLITHIKUM, IBERISCHE HALBINSEL

ABSTRACT: A proximal phalanx of an equid discovered at Cerro de la Virgen (Granada) and considered in former publications as belonging to *Equus (Asinus) hydruntinus* has been re-dated by means of the radiocarbon method. This specimen dates to the early Middle Ages. This result, together with additional finds commented in the text, question the hypothesis about the existence of the european wild ass during the third millennium BC on the Iberian Peninsula

KEY WORDS: WILD ASS, *EQUUS HYDRUNTINUS,* CHALCOLITHIC, IBERIAN PENINSULA

RESUMEN: Se lleva a cabo en este trabajo una nueva datación por medio del radiocarbono de una falange proximal de un équido descubierto en el Cerro de la Virgen (Granada) que fue considerado en anteriores trabajos como perteneciente al encebro *Equus (Asinus) hydruntinus*. Este especimen data de la Alta Edad Media. Tal resultado, unido a hallazgos similares que se comentan en el texto, cuestionan la hipótesis en torno a la existencia del asno salvaje europeo durante el III milenio a.C. en la Península Ibérica.

PALABRAS CLAVE: ENCEBRO, *EQUUS HYDRUNTINUS*, CALCOLÍTICO, PENÍNSULA IBÉRICA

Im Jahre 1965 wurde bei archäologischen Ausgrabungen auf dem Cerro de la Virgen bei Huescar in Hochandalusien (Leiter: Prof. Dr. W. Schüle) zwei Equidenfesselbeine gefunden, die sich durch ihren außerordentlich schlanken Bau markant von Pferdephalangen und durch ihre Größe von Hauseselphalangel underscheiden. Beide Fundstücke, ein vorderes (F 938) und ein hinteres Fesselbein (F 683), wurden von Boessneck (1967, 104 f.; 1969; 1973, 280 ff.) vorgestellt und aufgrund ihrer auffallenden Proportionen zum Europäischen Wildesel, *Equus (Asinus) hydruntinus* (Regalia, 1907), gestellt. Bei ihrem Auffinden "datierte" der Ausgräber die beiden Phalangen euphorisch in die Phase Virgen I, d. h. in die Kupferzeit. Insgesamt umfassen die archäologischen Funde vom Cerro de la Virgen eine Sequenz von der entwickelten Kupferzeit (Schicht I) über die Glockenbecherzeit (Schicht II)

bis zum Ende der Argarzeit (Schicht III). Die oberflächennahen Lagen der Siedlung auf dem Hügel enthielten zudem Reste der arabischen Zeit (Schicht IV = ab 714 n. Chr.). Im Verlauf weiterer archäologischer Arbeiten auf dem vorgeschichtlichen Hügel mußte der Ausgräber die Datierung des vorderen Fesselbeins aus F 938 revidieren; die Fundeinheit ließe sich mangels datierbarer Keramik zeitlich nicht zuweisen, hieß es, die Datierung des hinteren Fesselbeins in die Phase Virgen I sei jedoch richtig.

In ihrer zusammenfassenden Studie über archäozoologische Aktivitäten auf der Iberischen Halbinsel folgte von den Driesch (1972, 117 ff.) der tierartlichen Einordnung der in Frage kommenden Phalangen durch Boessneck, trotz der aufgekommenen Zweifel an der Datierung vorderen Phalanx 1. Denn die Diagnose schien bestätigt durch einen weiteren Fund aus Südspanien, nämlich durch eine ähnlich große vordere Phalanx 1 wie aus F 938 aus Terrera Ventura, Prov. Almeria (Tabelle 1), die die Autorin im Sommer 1971 in einer Vitrine im Museo Arqueológico Provincial in Almeria entdeckte und maß (Abbildung 1). Im Gegensatz zu der Phalanx 1 anterior vom Cerro de la Virgen ist deren Einstufung in die Kupferzeit zweifelsfrei, da sie auf der Palmarseite, kurz unterhalb der proximalen Gelenkfläche ein eingeritztes Dreieck trägt (Abbildung 1), ein für die Los Millares-Kultur Südspaniens charakteristisches Idolzeichen (Topp & Arribas, 1965; vgl. auch Maier, 1961/62, 177), das die weibliche Scham andeutet. Equidenfesselbeine in un- und bearbeiteter Form dienten nämlich in dieser Kultur als anthropomorphe Körper, die man, auf die proximale Gelenkfläche gestellt, als weibliche Torsen, sog. Fruchtbarkeitsidole verehrte und in die Gräber mitgab (Leisner & Leisner, 1943).

Angeregt durch die von Boessneck und von den Driesch geäußerten Vermutungen bestimmte Uerpmann (1976) weitere Funde von *Equus hydruntinus* aus der Cueva de Carigüela bei Piñar in der Provinz Granada (Ausgräber Prof. Dr. J. Pellicer). Die Funde sollen in das mittlere und späte Neolithikum sowie in die Kupferzeit datieren. Doch da außerdem bronzezeitliche Bestattungen in der Höhle aufgefunden wurden, ist eine Einmischung jüngerer Funde nicht auszuschließen. Uerpmann stellt Einzelzahnfunde und einen bruchstückhaften Talus vor. Die Zähne hält der Autor aufgrund ihres Schmelzfaltenbildes mit dem für Asiniden kennzeichnenden Form von Metaconid und Metastylid und dem tiefen Außental für *Equus hydruntinus*. Alles in allem sind die von Uerpmann vorgestellten Schmelzfaltenbilder (l. c. Abb. 6, 1-3) nicht überzeugend, und der Talus ist nur fragmentarisch erhalten. Es sei jedoch aufgeführt, daß letzterer sich in der gleichen Schicht fand wie ein proximales Metacarpusfragment eines Wildpferdes, dessen Radiocarbondatierung ein Alter von 7010 ± 90 BP ergab (Uerpmann, 1990, 113).

Nachdem nun trotz neuerer Ausgrabungen in neolithisch-kupferzeitlichen Ansiedlungen Südspaniens, darunter auch neuer Grabungen auf dem Cerro de la Virgen Anfang der 70er Jahre (von den Driesch unveröffentlicht), außerdem in Los Millares (Peters & von den Driesch, 1990) sowie in Los Castillejos bei Montefrio (Ziegler, 1990; Riquelme, 1996) keine weiteren Funde von *Equus hydruntinus* zum Vorschein kamen, verdichteten sich die von Anfang an gehegten Zweifel (von den Driesch, 1972, 119) an der tierartlichen Bestimmung der drei oben vorgestellten Phalangen. Das vordere Fesselbein aus F 938 vom Cerro de la Virgen, das damals nach Deutschland mitgenommen

Fundnummer	F938	F638	-
Größte Länge	88,0	77,0	86,8
Breite proximal	(42,5)	41,0	42,7
Tiefe proximal	(31)	30,0	31,0
Kleinste Breite der Diaphyse	27,5	26,3	29,0
Breite distal	(39)	37,0	38,5
Extremität	anterior	Posterior	anterior
Herkunft	Cerro de la Virgen	Cerro de la Virgen	Terrera Ventura

TABELLE 1

Maße der besagten Fesselbeine vom Cerro de la Virgen und aus Terrera Ventura.

worden war, wurde zur ^{14}C-Datierung in das Leibniz-Labor für Altersbestimmung und Isotopenforschung der Christian-Albrechts-Universität Kiel eingesandt (Leiter: Porf. Dr. P. M. Grootes). An einer kleinen Probe aus der besagten Phalange wurde eine AMS-Messung durchgeführt (Labornummer KIA 4940 V 65). Über die Datierung liegen vom Labor folgende Angaben vor:

Radiocarbon age BP 1170 ± 20
Calibrated age(s) ca. AD 887, 935
one σ cal AD 783-787 813-817 832-838 870-897 922-944
two σ cal AD 780-791 802-901 912-980

Das deutlich jüngere Alter in das frühe Mittelalter bestätigt nun den Verdacht, daß am Cerro de la Virgen keine Reste von *Equus hydruntinus* vorliegen. Dieser grazile, kleine Equide war im Pleistozän in großen Teilen Europas beheimatet. Seine Zähne sind klein wie die der echten Esel. Die Innenpfeiler der Unterkieferzähne besitzen Ähnlichkeit mit der entsprechenden Morphologie des pliozänen *Equus stenonis* aus Nordamerika, der den Zebras nahe steht. Das postkraniale Skelett ähnelt in seiner Schlankheit dagegen eher dem Halbesel, *Equus hemionus*. Da in phylogenetischer Sicht dem Gebiß mehr Bedeutung beizumessen ist als den Proportionen des Bewegungsapparates, wurde er als echter Esel eingeordnet (Stehlin, 1933, 230). Nacheiszeitlich wurde *Equus hydruntinus* zur Genüge in Osteuropa nachgewiesen (z.B. Vörös, 1981). Wie Manhart (1998, 156 ff.) an Tierknochenfunden aus Durankulak/Bulgarien zeigen konnte, kam er aber dort nur noch sicher bis in das späte Neolithikum, evtl. bis zur mittleren Kupferzeit vor, d. h. wohl bis zur Mitte des 5. vorchristlichen Jahrtausends, nicht mehr jedoch im 4. Jahrtausend v. Chr.

Auch auf der Iberischen Halbinsel sieht es ganz so aus, daß sich dieser kleine Equide dort nicht bis zum Ende des 3. vorchristlichen Jahrtausends gehalten hat. Bei den meisten bisher vorliegenden, in ihrer zeitlichen Einordnung zweifelhaften Funden aus dem Süden der Iberischen Halbinsel muß an ihre Zugehörigkeit zu großen schlankwüchsigen Hauseseln gedacht werden (Abbildung 2). Dies trifft besonders für die nunmehr ins Mittelalter datierte Phalanx 1 anterior mit der Fundnummer 938 vom Cerro de la Virgen zu. Die hintere Phalanx I aus dem gleichen Fundplatz, die offenbar aus der frühesten Bewohnungsphase des Hügels kommt, könnte einem noch jugendlichen Pferd gehört haben und war deshalb in ihren Proportionen noch nicht voll entwickelt. Man erkennt hier am proximalen Ende noch Spuren der Epiphysenfuge (von den Driesch, 1972, Abb. 7a). Um eine Eselphalange kann es sich nicht handeln, denn in dieser frühen Zeit gab es den Hausesel in Spanien noch nicht, und eigentliche Wildesel kamen dort nicht vor. Alle diskutierten Fesselbeine sind übrigens extrem abgerieben (Abbildung 1), haben also während ihrer Lagerung im Boden einen gewissen Substanzverlust an der Außenseite erfahren, was eben zu der Täuschung bei der tierartlichen Bestimmung führte. Aber auch der aufgrund seiner für die Kupferzeit typischen Bearbeitung sicher datierte Fund aus Almeria müßte von einer anderen Tierart sein als der Europäische Wildesel. Man könnte hier an ein im Rahmen des Phalangen-Idolkultes eingeführtes Handelsgut aus dem Vorderen Orient (Halbesel) oder aus Nordafrika denken (Afrikanischer Wildesel). Unberührt von den Zweifeln bleibt der oben erwähnte kleine Talus der Cueva de Carigüela, der, da er in der gleichen Schicht wie der nachdatierte Pferdeknochen lag, nahelegt, daß der Europäische Wildesel zumindest bis zu Beginn des 5. Jahrtausends v. Chr. auf der Iberischen Halbinsel noch vorkam.

ABBILDUNG 2
Phalanx 1 anterior vom Cerro de la Virgen. Die Umrisse (weiß) dieser deutlich abgeriebenen Phalange wurden in die Umrisse eines rezenten männlichen Riesenesels (schwarz) zum Vergleich eingezeichnet.

Die hier diskutierten Equidenfunde vom Cerro de la Virgen sind so recht geeignet, die ganze Problematik der Equidenbestimmungen an Einzelfunden aus archäologischen Ausgrabungen noch einmal vor Augen zu führen.

ABBILDUNG 1

Vordere Phalangen 1 aus Tabernas (jeweils links) und vom Cerro de la Virgen (jeweils rechts in Dorsal- (die beiden linken Funde) und Palmaransicht (die beiden rechten Funde).

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Arqueofaunas de la Isla Livingston, Shetland del Sur. Un estudio exploratorio de los restos de mamíferos recuperados en la Península Byers

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RESUMEN: En este trabajo se analizan los restos óseos de mamíferos recuperados en la isla Livingston, Shetland del Sur, durante la campaña arqueológica antártica llevada a cabo en el verano 1995-96. Se discuten los principales agentes tafonómicos que pudieron contribuir a la formación y modificación de los conjuntos faunísticos estudiados, presentándose la información relevante para el estudio de la ocupación inicial y utilización de la isla por parte de grupos humanos. Los resultados alcanzados muestran que entre los mamíferos representados son los pinnípedos, locales, los que predominan, encontrándose en segundo lugar los no locales: cerdo y vaca. Se observa que los abrigos rocosos naturales son los *loci* que presentan la mayor variedad taxonómica, presentando también una mejor conservación de restos óseos. En todos los conjuntos predominan los huesos no fusionados o semifusionados. A partir de las evidencias directas de procesamiento se puede inferir que tanto los mamíferos locales como los no locales fueron utilizados por los humanos que habitaron la isla, aunque con diferente finalidad.

PALABRAS CLAVE: ANTÁRTIDA, ARQUEOFAUNAS, TAFONOMÍA

ABSTRACT: Mammal bones recovered in the 1995-96 Antarctic archaeological fieldwork in Livingston Island, South Shetland, are analized. The taphonomic agents involved in the formation and modification of these faunal assemblages are identified and discussed. Information relative to the initial occupation and subsequent use of the island by humans is also presented. Pinnipeds, which are local mammals, are the most abundant taxa, being the non-local fauna, pig and cattle, less abundant. Natural rockshelters are the *loci* with the highest taxonomic diversity, and the places where bones are best preserved. Non- or semi-fused bones are dominant in all the assemblages considered. Processing traces suggest that both local and non-local mammals have been used by humans, although with different goals.

KEY WORDS: ANTARCTICA, ARCHAEOFAUNAS, TAPHONOMY

INTRODUCCIÓN

La ocupación gradual de diferentes ambientes por nuestra especie puede trazarse en un *continuum* que abarca desde el poblamiento temprano de Asia y Europa hasta las exploraciones recientes en la Luna. El continente antártico forma parte de esa gran variedad de espacios explorados y colonizados y se caracteriza por haber permanecido al margen de las actividades humanas hasta tiempos muy recientes, fines del siglo XVIII. Varios son los factores que tienen que ver con esta situación, particularmente sus características propias, como la ubicación latitudinal extrema, las condiciones climáticas de ello derivadas, y el hecho de estar rodeado por amplios océanos, lo que lo posicionó marginalmente respecto del resto de las masas continentales. En

este sentido, puede decirse que la Antártida ha sido como una gran isla lejana.

La ocupación del continente austral no fue un hecho azaroso, sino que constituyó la expresión de un proceso socioeconómico de escala global, representado por la expansión del capitalismo a partir de la revolución industrial del siglo XVIII (Senatore & Zarankin, 1999). Este proceso de ocupación del espacio antártico, que aún no ha finalizado, supuso, para los grupos humanos que lo llevaron a cabo, enfrentarse no sólo con los riesgos inherentes a la impredictibilidad de los recursos propios de los ambientes insulares, sino también a los agravantes emergentes de las características climáticas mencionadas.

Desde su descubrimiento, las Shetland del Sur fueron visitadas por una cantidad de buques de diferentes nacionalidades, que se orientaron a la explotación de los mamíferos marinos que habitan las islas y aguas circundantes. Estas operaciones respondían a emprendimientos independientes de empresas que comercializaban los productos así obtenidos en distintos mercados, como el chino (Richards, 1992).

Las Shetland del Sur se encuentran al noroeste de la Península Antártica. Una de las islas más importantes de este archipiélago es Livingston, ubicada a los 62° 30' de latitud Sur y 60° 30' longitud Oeste. Desde 1995 la Península Byers, que ocupa un área de 72 km^2 en el extremo oeste de la isla Livingston (Figura 1), ha sido objeto de trabajos arqueológicos sistemáticos a cargo de los Lic. X. Senatore y A. Zarankin, en el marco del Programa Geocronología del Instituto Antártico Argentino. La investigación arqueológica tiene como objetivo general analizar el proceso de expansión y explotación humana de las tierras antárticas durante el siglo XIX y, en particular, las estrategias implementadas durante este proceso (Senatore & Zarankin, 1996). Lo que se busca investigar, en consecuencia, es la intensidad y frecuencia de estas ocupaciones, así como los principales factores que las determinaron. El primer paso para ello es explorar las propiedades del registro arqueológico en cuestión.

El estudio que aquí se presenta trata sobre una parte del registro arqueofaunístico recuperado en la isla Livingston, los restos de mamíferos, y tiene dos objetivos principales. En primer lugar explorar, desde un punto de vista tafonómico, la naturaleza de las muestras arqueofaunísticas mencionadas. El segundo objetivo consiste en evaluar la información que estos conjuntos faunísticos ofrecen para el estudio de la explotación humana de la isla. El objetivo, en ambos casos, es realizar una primera caracterización del registro arqueofaunístico de la península que sea de utilidad para avanzar en las sucesivas etapas de la investigación.

MATERIALES Y METODOLOGÍA

Los restos óseos fueron recuperados en la campaña arqueológica antártica del verano de 1995-96. Como se señaló, los trabajos de campo tuvieron lugar en la Península Byers de la Isla Livingston (Figura 1). La información general sobre estos trabajos y los posteriores (datos de procedencia de los recintos, densidad de materiales, etc.) está siendo publicada en una cantidad de trabajos, a los que se refiere para un mayor detalle (Senatore & Zarankin, 1996, 1997, 1999; Zarankin & Senatore, 1996, 1997, 1998; Muñoz, 1997; Moreno, 1999). Como se mencionó, aquí se presentan únicamente los restos de mamíferos, incluyendo en ello a los marinos y los terrestres, con excepción de los cetáceos. Esto se debe a que, por su tamaño, éstos no pudieron ser transportados para su análisis en el laboratorio, y por lo tanto no se les pudo dar el mismo tratamiento que al resto de los materiales aquí considerados. Los restos faunísticos no han sido fechados directamente, pero los estudios efectuados sobre los fragmentos de vidrio encontrados en los mismos depósitos indican que éstos corresponderían al período definido entre los años 1794 y 1820 (Moreno, 1999).

De las 22 estructuras y cuevas relevadas en la campaña 1995-96, sólo seis presentaron restos faunísticos de este tipo. En la Tabla 1 se observa que los sitios con restos de mamíferos proceden proporcionalmente del norte y sur de la Península Byers. Sin embargo, dos son cuevas (Lima Lima 1 y 2), mientras que los cuatro restantes son sitios y/o estructuras a cielo abierto en los que aún no se han llevado a cabo excavaciones. El único sitio donde se obtuvo un conjunto en estratigrafía es Lima Lima 1, mientras que en los cinco sitios restantes, los restos óseos recuperados son los que se hallaban en superficie.

Como se analiza más adelante (Tabla 2), un problema que plantean estos conjuntos es su reducido tamaño, lo que, en consecuencia, no permite formular más que tendencias preliminares. Consi-

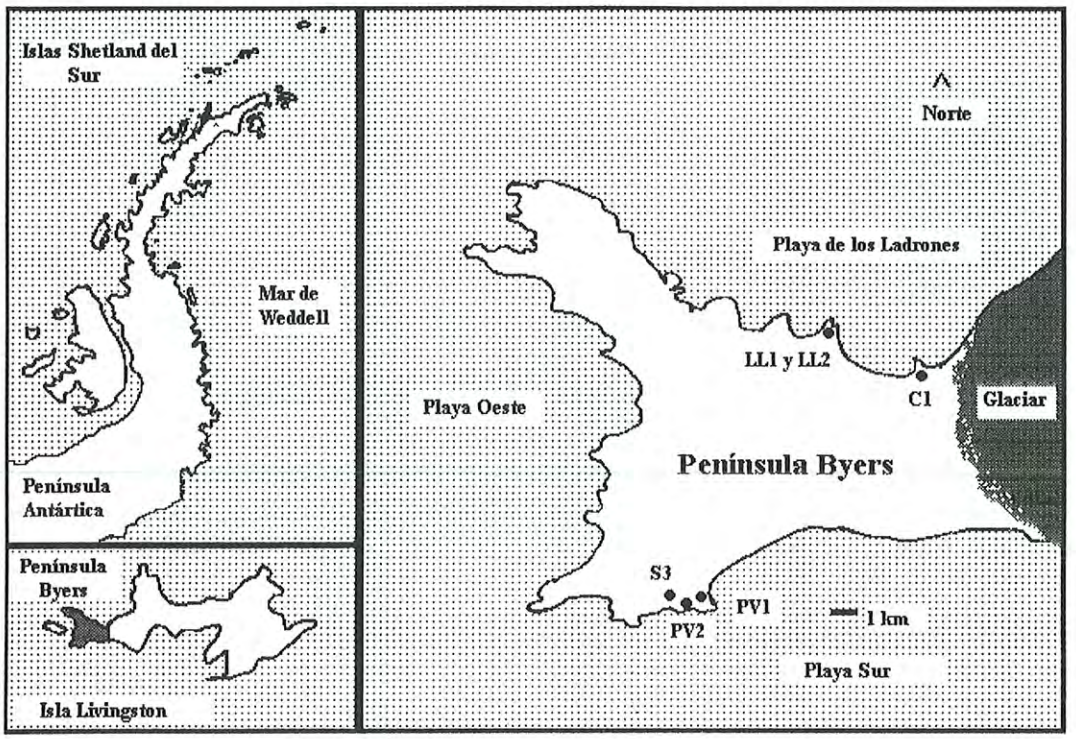

FIGURA 1

Isla Livingston, Shetland del Sur. Localización de los sitios arqueológicos considerados en el trabajo.

Península Byers	Playa	Sitio Arqueológico
Norte	de los Ladrones	Lima Lima 1 Lima Lima 2 Cutler 1
Sur	Sur	Punta Vietor 1 Punta Vietor 2 Sealer 3

TABLA 1

Procedencia de los conjuntos faunísticos estudiados.

deramos, sin embargo, que por constituir prácticamente la totalidad del registro zooarqueológico recuperado hasta el presente en el área, estos materiales deben ser presentados y discutidos, para de este modo refinar las hipótesis más generales con las que en la actualidad se están abordando las investigaciones arqueológicas en esta región del continente antártico.

CUEVA LIMA LIMA 1 (LL1)

LL1 es una cueva con una superficie aproximada de 272,75 m^2 en la cámara principal, de los cuales 22,75 m^2 del fondo corresponden a un recinto. El resto de la cámara, aquí denominada cámara mayor, fue dividida a los fines del relevamiento en cuatro sectores de aproximadamente 60 m^2 cada

Procedencia	NISP Pinnípedos	NISP Cerdo	NISP Vaca	NISP Mamífero grande	NISP y NSP Mammalia	**NISP Total**
LL1 Recinto (estratigráfico)	41	10	2	-	42	95
LL1 Recinto (superficie)	29	2	1	-	16	48
LL1 Cámara (superficie)	3	3	-	-	7	13
LL2 Cámara (superficie)	26	4	-	2	16	48
C1 (superficie)	17	-	-	2	23	42
PV1 (superficie)	-	-	1	-	-	1
PV2 (superficie)	3	-	-	-	-	3
S3 (superficie)	2	-	-	-	-	2
Total	**121**	**19**	**4**	**5**	**104**	**252**

TABLA 2

Restos óseos de mamíferos terrestres y marinos recuperados en los seis sitios arqueológicos considerados en el trabajo. Se distinguen materiales de superficie y estratigráficos. Datos tomados de las Tablas 5 a 10 del Apéndice.

uno (A, B, C y D). La cámara menor se encuentra en forma contigua y se denomina Lima Lima 2 (Senatore & Zarankin, 1996).

Se relevó la superficie total de la cueva y se excavaron 3 m^2 dentro del recinto y 1 m^2 en la cámara mayor, sector C. Los materiales recuperados constituyen la única muestra estratigráfica aquí considerada. La excavación en el recinto se realizó en las cuadriculas E3, H3 y F2. La cuadrícula planteada fuera del recinto se ubica en el centro de la cámara (H11, sector C), pero no ofreció evidencia de ningún tipo (Senatore & Zarankin, 1996). Las cuadrículas cubrieron una superficie de 1 m^2 cada una, siendo la más rica en restos de mamíferos la E3.

De las recolecciones de superficie realizadas en el recinto, los restos de mamíferos se localizaban en las cuadrículas E2, E3, F2, F4, G3, G4 y H2, mientras que fuera del recinto este tipo de evidencia se encontró en tres de los cuatro sectores en que fue dividida la cámara para su relevamiento (Tablas 5 y 6).

CUEVA LIMA LIMA 2 (LL2)

Se trata de la nave menor de la cueva Lima Lima, con una superficie aproximada de 55 m^2. En general las características microambientales de esta cámara menor se asemejan a las de LL1. La principal diferencia tiene que ver con las características del sustrato, que en Lima Lima 1 es más fino. Los materiales fueron recuperados por recolección de superficie en las cuadrículas (de 1 m^2) R1, R2, R3, S1, S2, S3, Q1 y Q2, ubicadas hacia el final de la cueva, sobre una de sus paredes. De tal modo, la superficie relevada fue de 7,2 m^2. Fuera de esta zona de recolección se planteó una novena cuadrícula (P5), que no presentó hallazgos de ningún tipo (Senatore & Zarankin, 1996).

CUTLER 1 (C1)

Se trata de dos recintos (C1a = 7,40 m^2 y C1b = 10,50 m^2), alrededor de los cuales se efectuó una intensiva recolección de superficie, no encontrándose evidencias en el interior de los mismos. Además de los restos aquí tratados se observaron también en superficie restos faunísticos de cetáceos. La superficie total relevada es de 17,90 m^2 dentro de los recintos y 200 m^2 en el exterior, en 8 cuadrantes de 5x5 m (Senatore & Zarankin, 1996). Los materiales provienen de los cuadrantes B3, C1 y D3. Este conjunto estaba depositado plenamente al aire libre, a unos 10 metros de la línea de mareas altas.

PUNTA VIETOR 1 Y 2 (PV1 Y PV2)

PV1 es un recinto cuadrangular de 7,85 m^2 ubicado a uno 15 m del mar. El relevamiento efectuado en la superficie interna y externa del recinto cubrió 35 m^2, en los que se relevaron diversos materiales arqueológicos, entre ellos huesos de cetáceos. Sólo un espécimen fue recuperado. Se trata de un húmero proximal fusionado de vaca.

PV2 es también un recinto cuadrangular y está constituido por dos estructuras. La de mayor tamaño alcanza los 9,60 m^2, mientras que el anexo

cubre 6,90 m^2. La superficie total relevada en este caso alcanza los 90 m^2, de los cuales 73,5 m^2 corresponden al exterior de las estructuras. Las mismas se ubican a mayor distancia de la costa que PV1, a unos 90 m aproximadamente. A diferencia de lo observado en PV1, en PV2 se rescataron exclusivamente restos de pinnípedos (Senatore & Zarankin, 1996).

CERRO SEALER 3 (S3)

Cerro Sealer 3 está compuesto por dos estructuras cuadrangulares, una de 16,15 m^2 y otra más pequeña de 4 m^2. Se encuentra a 200 m del mar. Los únicos restos recuperados corresponden a mamíferos marinos, uno de ellos posiblemente de elefante marino (*Mirounga leonina*) (Senatore & Zarankin, 1996).

En síntesis, los materiales fueron recuperados en los puntos que presentaban mayores evidencias de modificación humana. Esto incluye tanto a los abrigos naturales como a las estructuras construídas. La metodología de campo seguida para su recuperación consistió en la recolección de superficie y excavación, en cuyo caso se siguieron las capas naturales por extracciones artificiales de 5 cm, utilizándose una malla de 5 mm para el cribado del sedimento.

Los restos faunísticos fueron relevados macroscópicamente, utilizando lupa de mano con 3 y 4 aumentos. Los datos completos del relevamiento realizado se presentan en el Apéndice final del trabajo.

Los conjuntos óseos son analizados, principalmente, a partir del número mínimo de individuos (MNI) número de especímenes (NSP), número de especímenes identificados anatómica y taxonómicamente (NISP) y el número mínimo de elementos (MNE), (Lyman, 1994). En el Apéndice se presentan otros datos también, como el porcentaje de supervivencia. Para la identificación de los restos faunísticos se utilizaron las colecciones de referencia disponibles en el Programa de Estudios Prehistóricos (CONICET, Rep. Argentina). Alternativamente se recurrió a publicaciones como la de Kasper (1980) y King (1983), en el caso de los pinnípedos y Getty (1982) y Barone (1990) para los domésticos, entre otros.

Dado lo reducido de los conjuntos, se optó por agrupar los restos de mamíferos marinos dentro de una única categoría que denominamos Pinnípedos, sin distinguir a nivel de especie, ya que esta resolución es concordante con las preguntas planteadas en esta etapa de la investigación, y una clasificación más específica no habría ampliado sustancialmente la información obtenida. Las especies que habitan la zona incluyen, además del ya mencionado elefante marino, a *Arctocephalus gazella, Leptonychotes weddelli, Ommatophoca rossi, Lobodon carcinophagus, Hydrurga leptonyx* y probablemente *Arctocephalus tropicalis*, por lo que son éstas las especies potencialmente comprendidas por la categoría Pinnípedos. Como se señaló, los restos de artiodáctilos corresponden al cerdo (*Sus scrofa*) y la vaca (*Bos taurus*) domésticos. En los casos en que no se pudo asignar los restos específicamente a este último taxón se optó por hacerlo en la categoría Mamífero Grande, aunque dado que es muy probable que correspondan a vaca en el análisis se suelen considerar ambas categorías en conjunto, bajo le rótulo M.G. Finalmente, ya que muchas de las costillas no pudieron ser identificadas a nivel de especie, debido a la ausencia de los rasgos más diagnósticos, o por tratarse en varios casos de individuos inmaduros se las considera a todas en un nivel más general (Mammalia).

RESULTADOS

La mayor cantidad y variedad de restos faunísticos de mamíferos proviene de la costa norte de la Península Byers (Tabla 2; Apéndice). Los taxones más importantes son los pinnípedos y el cerdo, estando representados los primeros por un MNI en un rango que va de un único individuo hasta un máximo de 7. El cerdo está representado por un MNI entre 1 y 2. Los restos asignables a vaca y mamífero grande dan cuenta de un único individuo, se los considere en forma separada o agregada (ver Apéndice). Los conjuntos de la costa sur, a pesar de provenir de la misma cantidad de sitios, están compuestos por muy escasos restos, predominando entre ellos los de pinnípedos, salvo PV1, con un único hallazgo de fauna alóctona: un húmero proximal fusionado de vaca.

Conjuntos de superficie

La muestra analizada está compuesta, principalmente, por conjuntos de superficie, que provienen de distintos *loci,* como cuevas y partes internas y externas de estructuras. Esto planteó diferentes con-

diciones microambientales para la conservación de los materiales faunísticos, lo que en parte se ve reflejado en las propiedades que presentan los distintos conjuntos. Por ejemplo, la cámara de las cuevas es un ambiente muy húmedo y frío, que mantuvo congelado el suelo durante la mayor parte del tiempo que ocupó el trabajo de campo arqueológico (X. Senatore com. pers.). Estas condiciones no son las mismas que afectaron a los conjuntos expuestos depositados en C1 y otros sitios a cielo abierto. Otras características, como el sustrato y la distancia relativa a la línea de altas mareas también difieren entre los *loci* estudiados y pueden ser importantes para entender la historia tafonómica de los conjuntos óseos, principalmente porque las diferencias microclimáticas ejercen una profunda influencia en las posibilidades de preservación de los restos orgánicos en tan altas latitudes (Sutcliffe, 1990).

El cuadro general que presentan los conjuntos de superficie se puede describir de la manera que sigue. De acuerdo al índice MNE/NISP, los restos identificables anatómicamente y a nivel de especie presentan una fragmentación prácticamente nula (Tabla 3). Esto se relaciona, principalmente, con lo limitado de las muestras, lo que determina una alta correspondencia entre NISP y MNE. Aunque el reparo natural más importante de la península, la cueva LL1, pudo ser el *locus* utilizado de forma más repetida, no se observó ni una mayor fragmentación, ni una mayor proporción de fragmentos no identificables. Tampoco se observaron marcas que puedan relacionarse con pisoteo, aunque cabe aclarar que en muchos casos el relevamiento de las modificaciones óseas se vio imposibilitado por el estado de las superficies óseas.

Los especímenes que no pudieron ser identificados anatómicamente son más importantes en C1 (Tabla 2 y Apéndice). Esto se explicaría, en principio, por el hecho de que las superficies de los huesos expuestos se meteorizan más rápidamente que los que están protegidos por un abrigo (Sutcliffe, 1990), afectando, de este modo, las posibilidades de identificación de los materiales.

Así, a partir de una comparación sumaria entre las Figuras 2, 3 y 4, se observa que en la costa norte los dos conjuntos procedentes de cuevas están mejor conservados que en C1, el único de los sitios expuestos en esta zona con restos óseos. En efecto, más del 70% de los restos de pinnípedos en superficie de LL1 y LL2 registran estadios entre 0 y 1 de meteorización (*sensu* Behrensmeyer, 1978), y muy pocos superan el estadio 2. La situación opuesta se observa en C1, donde más del 90% de los restos asignados a este taxón se encuentran en el estadio 4 de meteorización. Algo similar sucede con los restos de cerdo hallados en las cuevas, que no registran una alta meteorización (siempre es inferior al estadio 3), siendo los estadios más representados el 2 y el 0, en LL1 y LL2, respectivamente.

En la costa sur no podemos hacer este tipo de comparaciones debido a que las muestras son más pequeñas aún. El único espécimen óseo de vaca, proveniente de PV1, y los dos de mamífero marino de S3 tienen una meteorización que corresponde al estadio 1, mientras que los tres especímenes óseos de pinnípedos recuperados en PV2 se asemejan a lo observado en C1, ya que todos ellos presentan una meteorización avanzada (estadio 3).

Respecto de Mammalia, se observa que los diferentes estadios de meteorización están representados en forma bastante pareja en los conjuntos de LL1 y LL2 y no en C1, donde predominan los estadios 2 y 3. Como se señaló más arriba, esto es esperable ya que en la pérdida de identificabilidad contribuyen una variedad de procesos entre los que se encuentra la meteorización.

Las diferencias observadas en la costa norte entre los abrigos naturales y los sitios a cielo abierto confirmaría la importancia que la meteorización subaérea tiene en los ambientes expuestos de la península. Dadas las características generales de la isla, esto podría estar relacionado también con una tasa de enterramiento lenta. Sin embargo, aún desconocemos el ritmo con que la degradación observada en los huesos ocurrió, por lo que no es posible hacer una ecuación directa entre estadios representados y tiempo transcurrido.

También desconocemos otros procesos que pudieron afectar la formación de estos conjuntos. Por ejemplo, a pesar de su avanzado estadio de meteorización, en C1 las superficies de los huesos se encontraban estabilizadas. Es decir, aunque están presentes todas las características propias de los estadios 3 y 4 de meteorización, los huesos no tienden a desintegrarse a partir de las grietas abiertas. Es muy probable que la exposición al agua marina haya afectado las características propias de los huesos, disminuyendo la velocidad de la meteorización de los mismos. Esta particularidad, alta meteorización y superficies estabilizadas, resultaría de las características ambientales generales que dominan en la isla, bajas temperaturas pero con

alta influencia marina, y debe ser investigada en el futuro para poder definir la magnitud con que los conjuntos expuestos resultan sesgados.

Este factor no es, sin embargo, el único a tener en cuenta, ya que las diferencias observadas en el grado de meteorización que presentan los materiales expuestos de distintos *loci* se ven afectadas también por la densidad global de los elementos óseos de los taxones considerados, pinnípedos por un lado y cerdo y vaca por otro. Al respecto corresponde señalar que entre los restos de fauna local recuperados en las cuevas predominan los huesos no fusionados (Figura 5). Algo similar sucede con los restos de cerdo, aunque en este caso es posible dar una mayor precisión de las clases de edad representadas. En LL1 los restos corresponden a individuos menores de 42 meses, mientras que en LL2 a individuos que no superaron los 36 meses (a partir de Getty, 1982: Tablas 37-1 y 37-2). Los restos de vaca recuperados en C1 corresponden a un individuo de entre 36 y 42 meses de edad (a partir de Getty, 1982: Tablas 26-1 y 26-2).

Dado que en estas latitudes los huesos depositados en superficie pueden estar en avanzado estado de meteorización en su cara expuesta y aún conservar tejidos blandos en la o las caras en contacto con el suelo, es importante no sólo registrar el grado de meteorización que presentan los especímenes óseos sino, también, la homogeneidad o heterogeneidad con que se distribuye en cada una de ellas. En contra de lo esperado, la mayoría de los restos óseos en superficie de la Península Byers presentaron una meteorización homogénea en todas sus caras. Esto sugiere que en la mayoría de los casos los huesos sufrieron movimientos y, en consecuencia, no habrían permanecido en situaciones de estabilidad durante lapsos lo suficiente prolongados como para desarrollar meteorización diferencial en sus caras. La excepción a esta situación podría ser la menor de las cuevas –LL2–, donde dos restos de pinnípedo, uno de cerdo y uno asignable a Mammalia presentan una meteorización no homogénea de las superficies. Queda por investigar si son las condiciones microambientales presentes en LL2, esto es, un ambiente intermedio entre la zona más abrigada de LL1 y la exposición total de C1, las que favorecen tal resultado.

Aunque un ritmo lento de enterramiento pueda ser una característica común a los diferentes conjuntos, en el caso de las cuevas no deben descartarse procesos específicos, distintos a la meteorización subaérea, que determinan en alguna proporción las características macroscópicas y estructurales de los huesos. Este podría ser el caso de la colonización por musgos y la degradación hidráulica sin desplazamiento (ver más adelante). La colonización por musgos es importante porque, aunque no afecte las superficies óseas, facilita su fractura, ya que éstos aprovechan las oquedades de los huesos para instalarse (Borella, 1994). En LL1 el 3,27% de los huesos han sido colonizados por musgos, mientras que la proporción en LL2 es mayor, alcanzando al 14%. Los restos de los otros conjuntos no presentan evidencias de este tipo, ni se han registrado indicios de colonización por líquenes. La baja proporción de especímenes óseos colonizados por musgos es un dato coincidente con la baja fragmentación presente en los conjuntos.

En LL2, la mayor importancia que tienen los musgos, así como la representación no homogénea de los estadios de meteorización señalada para algunos huesos de LL2, podría estar indicando condiciones microambientales puntuales que favorezcan una mayor estabilidad de los huesos depositados en este sitio.

En lo que a las características del sustrato se refiere, es importante destacar que la ausencia de suelos y sedimentos finos no implica necesariamente la imposibilidad de enterramiento y conservación. Observaciones tafonómicas realizadas por

Procedencia	MNE/NISP Pinnípedos	MNE/NISP Cerdo	MNE/NISP Vaca	MNE/NISP Mamífero Grande	NSP Mammalia indeterminado anatómicamente
LL1, Recinto	1	1	1	-	12
LL1, Cámara	1	1	-	-	5
LL2, Cámara	0.84	1	-	1	6
C1	1	-	-	1	20

TABLA 3

Fragmentación de los conjuntos óseos de superficie de la Playa Norte. Datos tomados de Tablas 5, 6, 8 y 9 del Apéndice.

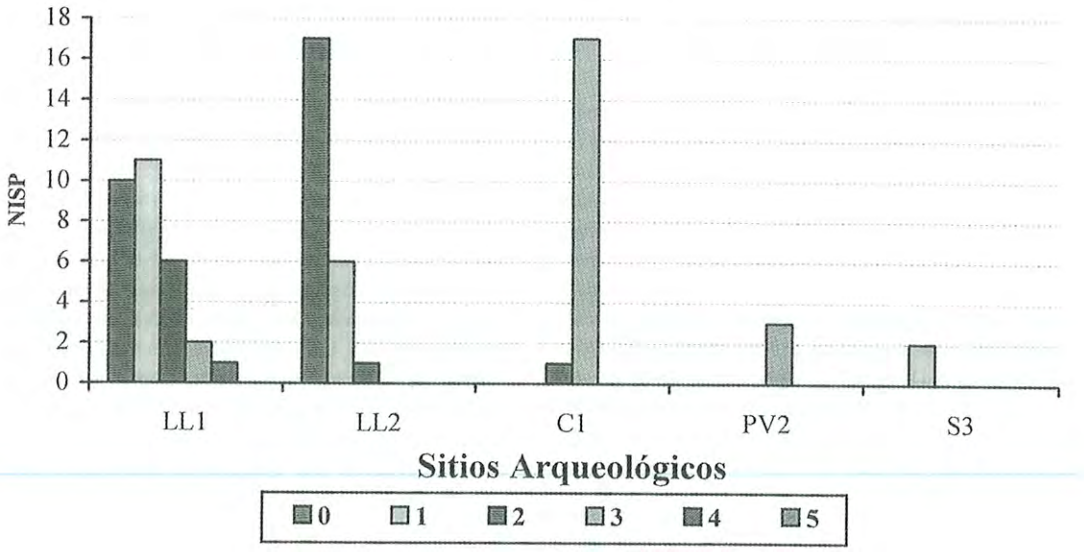

FIGURA 2

Costa norte y sur de la Península Byers. Estadios de meteorización representados en los restos de Pinnípedos en superficie. Frecuencias absolutas (NISP).

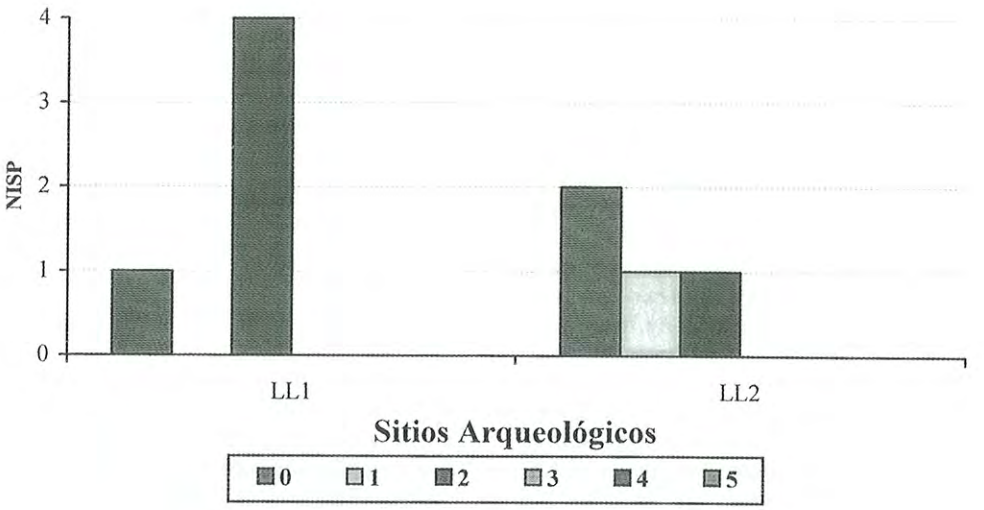

FIGURA 3

Costa norte de la Península Byers. Estadios de meteorización representados en los restos de cerdo en superficie. Frecuencias absolutas (NISP).

F. Borella y el autor en una antigua colonia de pinnípedos en Punta Páramo, Tierra del Fuego, sugieren que los huesos de tamaño pequeño a intermedio pueden incorporarse en un sustrato de guijarros, permaneciendo articulados y con meteorización baja, mientras que los restos expuestos y de mayor tamaño se encuentran en estadio 5 (Borella & Muñoz, Ms). La cuestión aquí es, sin embargo, establecer la importancia que el estrato activo tiene en los diferentes ambientes de la Península Byers, ya que esto afecta la posibilidad de incorporación al sedimento. Como sabemos, los

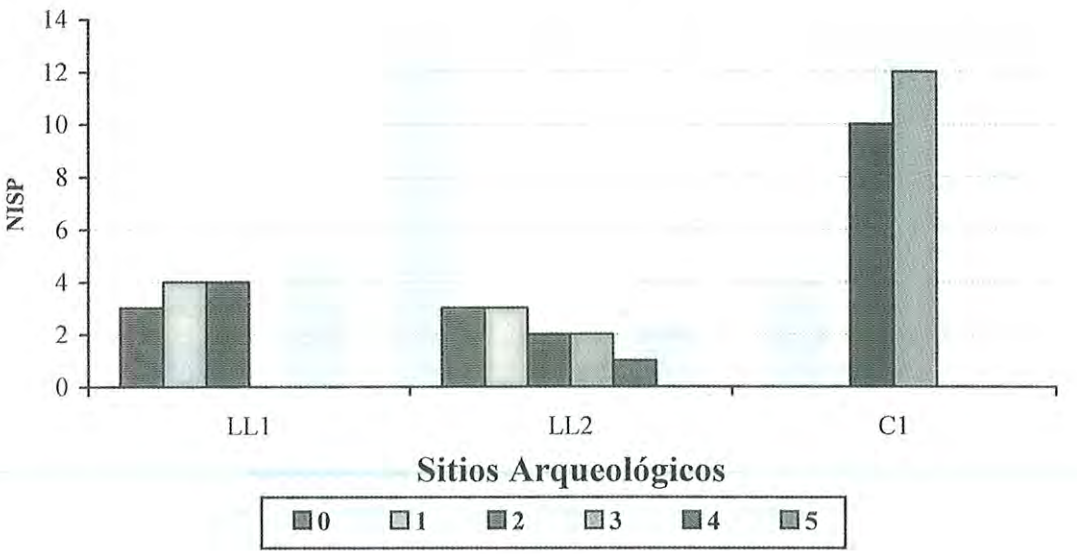

FIGURA 4

Costa norte de la Península Byers. Estadios de meteorización representados en los restos de Mammalia en superficie. Frecuencias absolutas (NSP y NISP).

suelos antárticos se desarrollan con un ritmo muy lento y, particularmente, en las zonas libres de hielo (Tatur & Myrcha, 1991, en Lauria Sorge, 1997), por lo que la disponibilidad de materia orgánica no constituye el único factor a tener en cuenta en estos casos.

Finalmente, las coloraciones observadas en los restos óseos de superficie procedentes de las cuevas incluyen principalmente al verde y el blanco, en menor medida el marrón y el gris y excepcionalmente el negro. En C1 los huesos tienen una coloración blanca y en segundo lugar marrón, mientras que el color dominante en los huesos de la costa sur es el marrón, seguido por el blanco y el verde.

Conjunto estratigráfico

El conjunto procedente de la excavación de LL1 no se diferencia sustancialmente de lo observado para los de superficie de ambas cuevas. La fragmentación de los restos de pinnípedos es baja (MNE/NISP = 0,83), encontrándose algunos elementos óseos no fusionados al momento de la muerte del animal (Figura 6). Los restos de mamíferos alóctonos se encontraban prácticamente enteros y en su mayoría sin fusionar (Figura 6). Los de cerdo correponden a individuos de entre 36 y 42 meses de edad (a partir de Getty, 1982: Tablas 37-1 y 37-2), mientras que los de vaca se ubican entre los 36 y 48 meses de edad. Los restos de vaca recuperados en C1 corresponden a un individuo de entre 36 y 42 meses de edad (a partir de Getty, 1982: Tablas 26-1 y 26-2).

La meteorización de los restos de pinnípedos no supera el estadio 2, siendo el más importante el estadio 1. Esto se asemeja a lo observado en el conjunto de superficie de LL1, donde también domina el estadio 1 (Figuras 2 y 7). La diferencia radica en que el conjunto de estratigrafía tiene menos estadios representados y, comparativamente, una menor importancia del estadio 0, diferencia que es aún más marcada si se lo compara con el conjunto de LL2.

Es difícil estimar el tiempo de formación de este conjunto a partir de estas características, principalmente porque aún desconocemos el modo en que se jerarquizan las variables que influyen sobre el enterramiento y preservación en un ambiente como el de LL1 (Sutcliffe, 1990). Independientemente de la lectura que pueda hacerse del perfil de meteorización que presentan los restos óseos en el recinto de LL1, existe evidencia de que algunos de los huesos habrían estado expuestos dentro del recinto el tiempo suficiente como para ser afectados por uno de los procesos derivados de la elevada humedad de la cueva. En efecto, en una costilla procedente de la cuadrícula E3 se observaron las

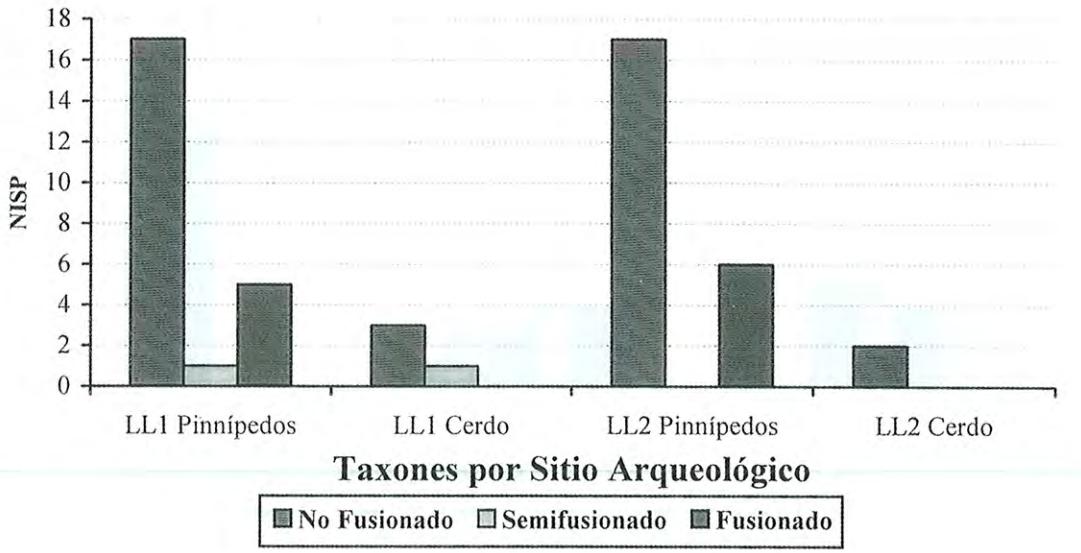

FIGURA 5

Costa norte de la Península Byers, cueva Lima Lima 1 y Lima Lima 2. Estado de fusión de los restos de Pinnípedos y cerdo en superficie. Frecuencias absolutas (NISP).

modificaciones propias de la degradación hidráulica sin desplazamiento. Este proceso, observado por Etxeberría Gabilondo & García Bartual (1996) en restos óseos de úrsidos depositados en ambientes de alta montaña, se caracteriza por la deformación de la superficie de los huesos a través de estrías y oquedades, que son producidas por aguas ácidas de baja temperatura. Al caer el agua de paredes y techo de la cueva produce charcos. Las sucesivas gotas producen ondas que hacen vascular los huesos de pequeño tamaño sobre su eje mayor. Gracias a este movimiento se produce la disolución

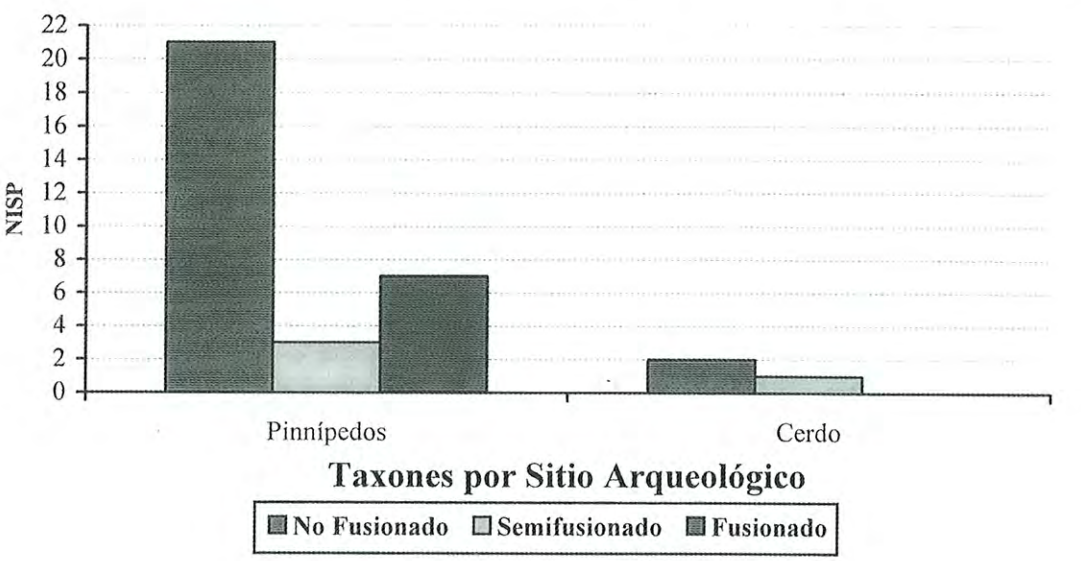

FIGURA 6

Costa norte de la Península Byers, cueva Lima Lima 1. Estado de fusión de los restos de Pinnípedos y cerdo en estratigrafía. Frecuencias absolutas (NISP).

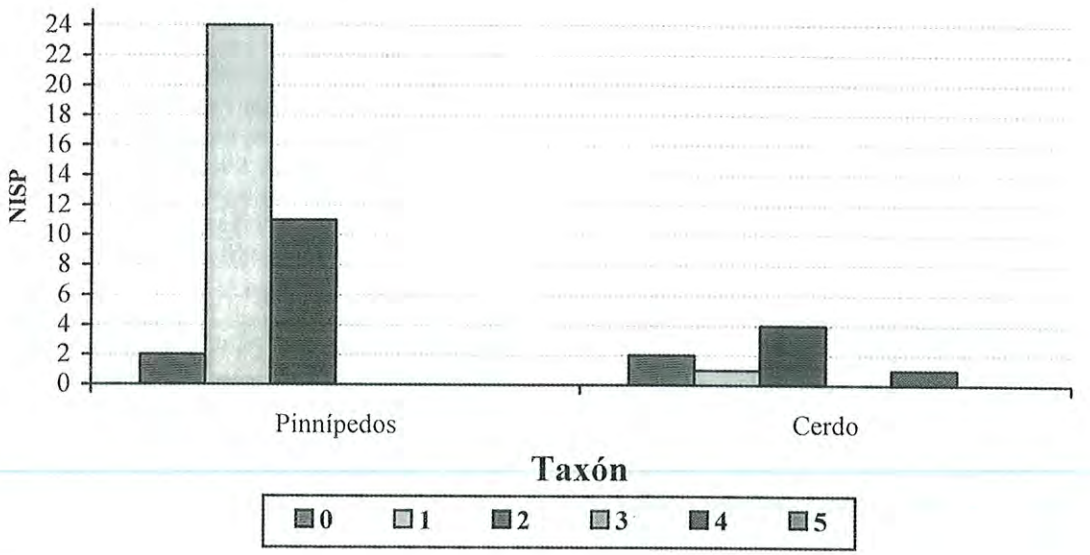

FIGURA 7

Costa norte de la Península Byers, cueva Lima Lima 1. Estadios de meteorización representados en los restos de pinnípedos y cerdo en estratigrafía. Frecuencias absolutas (NISP).

selectiva de las partes de huesos que apoyan sobre las piedras y guijarros (Etxeberría Gabilondo & García Bartual 1996: figura 2). En LL1 los huesos enterrados conservan una coloración marrón, aunque aún no está claro si la misma tiene un origen orgánico o inorgánico.

Modificaciones antrópicas

Un aspecto importante para discutir la relación de estos conjuntos con la actividad antrópica en la isla está dado por las evidencias directas del procesamiento de los huesos. Las huellas culturales fueron identificadas en todos los taxones, particularmente en las cuevas (Tabla 4).

En el conjunto de estratigrafía estas modificaciones tienen que ver con el despedazamiento de la presa y consisten en bordes de fracturas. Se trata de un metatarso de cerdo con fractura transversal a la altura de la epífisis distal y de un calcáneo de cerdo fracturado longitudinalmente para la extracción de la médula ósea. Otros especímenes, como dos vértebras cervicales, una de ellas de vaca, presentan fracturas sagitales pero sin elementos de diagnóstico claros como para considerarlas de origen cultural y, por ello, no se han incluido en la Tabla 4. Los restos alterados térmicamente en este depósito son dos, y no pudieron ser identificados anatómicamente.

En el conjunto de superficie de LL1 se halló un carpiano de pinnípedo con huellas producidas por

	Huellas de corte				Fracturas de origen cultural			Alteración térmica
Conjunto	Pin	Cerdo	M.G.	Mammalia	Pin	Cerdo	M.G.	Mammalia
LL1 estratigráfico	-	-	-	-	-	2	-	2
LL1 superficie	1	-	-	1	1	-	-	5
LL2 superficie	-	1	-	-	1	-	1	-
C1 superficie	-	-	1	-	-	-	1	-

TABLA 4

Modificaciones culturales. NISP con huellas culturales, fracturas y alteración térmica en la costa norte de la Península Byers. Abreviaturas: Pin = Pinnípedos, M.G. = Mamífero Grande

un instrumento cortante, probablemente metálico, y por su localización estarían relacionadas con el procesamiento de la presa para la extracción del cuero. Otra evidencia relacionada con el procesamiento de pinnípedos en este conjunto es menos clara: se trata de una primera vértebra sacra fracturada, posiblemente para desarticular la espina dorsal. Finalmente existe un último espécimen con huellas en LL1, un fragmento de tejido esponjoso con parte del tejido cortical presente, así como cinco fragmentos indeterminados con evidencias de alteración térmica.

En LL2 En LL2 se recuperó un fragmento de diáfisis de hueso largo, probablemente de vaca, con evidencias de percusión para lograr la fractura que permitió el acceso a la médula. Por lo que se refiere a la fauna local, en este sitio se halló sólo una vértebra con una fractura de origen antrópico.

En C1 se encontraron dos fragmentos correspondientes a mamífero grande con evidencias de procesamiento. Uno de ellos es un ilion, con cortes largos efectuados, como en el caso de LL1, por un instrumento afilado y metálico. El segundo, un acetábulo con evidencias de haber sido fracturado durante el procesamiento o consumo. Otros restos, como el húmero proximal de vaca procedente de PV1, no presentan huellas.

Puede observarse, entonces, que existen tanto evidencias de procesamiento de fauna local, al menos para extracción de cuero, como de procesamiento para el consumo de la fauna introducida.

DISCUSIÓN Y CONCLUSIONES

Como se señaló al principio del trabajo, debido a lo limitado de los conjuntos, sólo es posible presentar una primera caracterización del registro estudiado que, a modo de agenda, sirva de guía para los próximos pasos de las investigaciones arqueológicas en las Shetland del Sur (Senatore & Zarankin, 1996).

Aún sabemos poco sobre la tasa de descomposición de los restos óseos en ambientes de permafrost, ya que estas investigaciones se encuentran en sus etapas iniciales (Sutcliffe, 1990). En este sentido el análisis de los conjuntos de la Península Byers estimula la formulación de algunas preguntas, de cuya respuesta podrá resultar un mejor conocimiento del modo en que los procesos tafonómicos operan en la región. Por ejemplo, y conforme a lo esperado, los datos sobre meteorización muestran que las cuevas son, en general, *loci* con mejor conservación de restos óseos, particularmente de pinnípedos. Sin embargo, es necesario investigar el modo en que las diferentes variables (pH del sustrato, cantidad de humedad, grado de exposición al permafrost, viento, entre otras) afectan la conservación de los restos depositados en éstas y otras situaciones microclimáticas de la isla.

Trabajar sobre este tipo de variables será de utilidad para estimar el tiempo de conservación bajo las mejores condiciones posibles dentro de la localidad arqueológica (Sutcliffe, 1990), localidad que aquí definimos como Península Byers, pero también para establecer la jerarquía de procesos operantes y su expresión en las diferentes situaciones consideradas. En esta jerarquía es necesario ubicar procesos tales como la degradación hidráulica sin desplazamiento observada en LL1, la estabilización de la superficie de los huesos en avanzado estado de meteorización de C1, el origen y significado de las diferentes coloraciones observadas en los huesos expuestos y enterrados, así como otros procesos sobre los que aquí no se encontró aún evidencia, como la colonización por líquenes y el papel potencial que éstos tienen para la descomposición de los restos óseos depositados en zonas con diferente exposición solar. Estas observaciones no deberían limitarse a los restos óseos únicamente sino que deberían incluir los orgánicos en general, ya que en la mayoría de los casos los restos óseos fueron hallados en asociación con otros materiales de origen orgánico, tales como telas o zapatos y maderas (Senatore & Zarankin, 1996, 1997, 1999; Zarankin & Senatore, 1996, 1997, 1998).

Asimismo, en todos los casos es necesario calibrar el modo en que variables tales como la clase de edad y las propiedades densitométricas de los restos óseos se combinan con los diferentes procesos mencionados. Aunque los restos de pinnípedos y vaca de la costa sur son escasos, las diferencias que éstos presentaron en los estadios de meteorización sugieren que este es un tema que debe ser profundizado. El estudio de la meteorización en restos de aves de estos mismos sitios arqueológicos será también un paso importante para dar respuesta a este punto.

Respecto de las primeras ocupaciones humanas en las Shetland del Sur se puede señalar lo siguiente: a partir de las muestras consideradas se observa que los mamíferos predominantes (según NISP,

MNE y MNI) en la mayoría de los conjuntos son pinnípedos, es decir locales. En segundo lugar se encuentran el cerdo y la vaca, ambos alóctonos. Los huesos de cerdo fueron encontrados únicamente en los abrigos naturales de la costa norte, mientras que los de vaca se encontraron tanto en la costa norte como en la sur.

Conforme a lo esperado, los huesos de especies introducidas presentan señales de haber sido procesados para su consumo, observándose incluso fracturas que podrían corresponder a cortes comerciales, lo que sugeriría que estos alimentos pudieron haber ingresado como partes o porciones y no como carcasas. En contraste con esto, los restos de pinnípedos no presentan evidencias de haber sido procesados para su consumo. Esto no implica, sin embargo, que no lo hayan sido, ya que históricamente se sabe que podían serlo. Sin embargo, la expectativa de ello derivada es, probablemente, invisible en un sentido arqueológico, ya que lo que se consumía eran, preferentemente, vísceras como el hígado y el corazón (Spears, 1922, en Berguño, 1993b).

Es difícil determinar la resolución temporal de los conjuntos y no hay elementos que permitan aislar claramente un agente acumulador exclusivo en ninguno de ellos. No se puede, en consecuencia, descartar que se trate de palimpsestos, generados a partir de circunstancias variadas de deposición. En el caso de la fauna local, estas circunstancias incluyen tanto la deposición de huesos por muerte natural como la producida por las actividades humanas que se busca investigar.

En efecto, la zona de mayor abundancia natural de pinnípedos, esto es, las playas y roquerías próximas al océano, es también el lugar donde ocurrían las matanzas masivas (Stackpole, 1955: 34). Asimismo, sabemos que los pinnípedos usualmente permanecen en la línea de costa, pero que algunas especies ocupan eventualmente otras zonas, por lo que no podemos descartar áreas un poco más alejadas como potencialmente utilizadas por estos animales.

En otras palabras, debido a que los recintos y cuevas con evidencia de actividad antrópica se superponen espacialmente con la zona utilizada más frecuentemente por los pinnípedos, no puede descartarse de plano la posibilidad del aporte natural de huesos en estos *loci*. El punto aquí es sí las contribuciones naturales pudieron ocurrir sucesivamente desde el momento en que estos refugios fueron abandonados hasta la actualidad, a diferencia de lo que sucede con los huesos incorporados directamente por descarte de las actividades loberas. Como ejemplo de esta posibilidad baste señalar que en Península Byers se observó a estos mamíferos marinos ocupando una de las estructuras arqueológicas excavadas (X. Senatore, com. pers.).

Disponemos de algunas evidencias directas e indirectas de actividades de descarte generadas por las actividades de los loberos que apuntan directamente a la resolución temporal de los conjuntos. En el primer caso se trata de las huellas de procesamiento registradas en los huesos de los mamíferos locales y, en el segundo, de su asociación con materiales introducidos, incluyendo entre éstos a los restos de fauna alóctona con y sin huellas de procesamiento. El hecho de que muchos de los huesos de pinnípedos no están fusionados si bien no es un indicador discriminante, tampoco constituye un dato fuera de lo esperado. En principio nos informa que al menos parte de los depósitos podrían haberse formado en el verano, y sugieren que la caza se habría ejercido sobre los individuos más accesibles, que a su vez son los que poseen las pieles más valiosas.

Es decir, existen evidencias de que los conjuntos fueron, al menos en parte, generados por las actividades de los operarios de las empresas loberas, pero todavía no estamos en condiciones de definir, a partir del registro arqueofaunístico exclusivamente, una firma zooarqueológica que sea distintiva de ellas, principalmente porque no podemos descartar otras fuentes potenciales que hayan contribuido con huesos a estos conjuntos. Para discriminar entre estas situaciones será necesario no sólo ampliar las excavaciones iniciadas en el recinto de LL1 e iniciar otras en los lugares donde hoy sólo disponemos de información de superficie, sino también recurrir a las distintas líneas de evidencia recuperadas en los sitios estudiados como la asociación de los restos faunísticos con materiales de origen cultural.

Tampoco deben considerarse como homogéneas las situaciones de descarte de huesos originadas por las actividades antrópicas. Esto se debe, principalmente, a que las mismas fueron variables tanto en lo que al origen de las ocupaciones de los recintos y abrigos se refiere, como a su duración, o las actividades llevadas a cabo. En efecto, las actividades de los loberos ocupaban unas pocas semanas en el lugar, aunque también era posible que se extendiesen durante varios meses, cuando los equipos de operarios no podían ser rescatados. Sin duda esto planteó situaciones muy diferentes desde el punto de vista de las actividades de subsistencia de estos

grupos humanos, y tiene que haber implicado una jerarquización diferencial de los abrigos naturales y de recursos locales para dichas actividades en cada una de esas situaciones. En este sentido, la situación extrema seguramente estuvo generada por los naufragios, que implicaron soluciones improvisadas dentro de un esquema de subsistencia de por sí muy precario (Stackpole, 1955; Berguño, 1993b).

La característica más llamativa de las explotaciones loberas, no obstante, es la de haber formado parte de un ciclo muy corto y, a diferencia de las explotaciones balleneras que la sucedieron, en general no implicaron asentamientos estables (Berguño, 1993a). Las operaciones se realizaban con una inversión mínima de recursos. Esto implica, respecto de los operarios, que sólo se garantizaba la supervivencia de quienes llevaban a cabo la explotación de forma directa y, en un sentido más general, el que la explotación de estos espacios tenía un carácter episódico y fluctuante, derivado de la abundancia de recursos en el lugar de origen y la posibilidad de vender los productos en los mercados adecuados (Senatore & Zarankin, 1999). Desde un punto de vista arqueológico, entonces, la expectativa que de ello deriva es que estas ocupaciones hayan dejado registros arqueológicos escasos y sumamente variables, pero de relativamente alta resolución. Es importante destacar que por las condiciones mencionadas, las ocupaciones estacionales de la isla habrían implicado la introducción de pocos materiales y utensilios alóctonos, así como un uso y reciclado recurrente de materiales locales y de los pocos introducidos, los que se destinaban, principalmente, a garantizar las actividades cotidianas.

En síntesis, la información generada a partir de esta investigación constituye un primer paso para la investigación del registro zooarqueológico dejado por las primeras ocupaciones humanas en la isla. Su principal utilidad radica en que nos permite aumentar nuestro conocimiento sobre la naturaleza de un registro que fue generado en un período acotado de tiempo y lapsos breves, y que hasta ahora ha permanecido prácticamente desconocido. De allí la importancia de cada elemento de información de que podamos disponer que, aunque no sea sustancial en términos estadísticos, resulta crucial para comprender las ocupaciones humanas en ambientes marginales.

En tal sentido puede decirse que la evidencia presentada apoya parcialmente la hipótesis que relaciona estos conjuntos con las actividades de explotación de los pinnípedos y, en conjunto con las demás líneas de evidencia recuperadas, puede decirse que éstos están relacionados con las actividades de los loberos que explotaron la isla durante el siglo XIX. La discusión con detenimiento de esta hipótesis requiere, no obstante, del estudio de procesos y variables tafonómicos como los señalados más arriba, así como de los resultados que aporten estas otras líneas de evidencia, actualmente bajo estudio.

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APÉNDICE

Pinnípedos: MNI = 3

Elemento	E2	E3	F2	F4	G3	G4	G5	H2	NISP	MNE	% S.
Vértebras cervicales	2								2	2	9
Vértebras torácicas	2		1						3	3	4
Vértebras lumbares	1								1	1	6
Sacro	1								1	1	11
Escápula		1	1						2	2	33
Húmero	2	2	2						6	6	33
Radio								1	1	1	16
Ulna				1					1	1	16
Carpianos						1			1	1	2,7
Calcáneo			1						1	1	16
Metatarsianos	1								1	1	3,3
Carpiano/tarsiano			1						1	1	1,2
Metapodios		1	1						2	2	3,3
Falanges	1		2		1	1			5	5	2,9
Dientes			1						1	1	-
TOTAL	**10**	**4**	**10**	**1**	**1**	**2**		**1**	**29**	**29**	-

Cerdo: MNI = 1

Cráneo	1								1	1	100
Radio		1							1	1	50
TOTAL	**1**	**1**							2	2	-

Vaca: MNI = 1

Vértebra lumbar	1								1	1	
TOTAL	**1**								1	1	

Mammalia

Cráneo	1	1							2	1	
Costillas	1	1							2	2	
sub-total	2	2							4	3	
Fragmentos indet.	2	5	4	1					12		
TOTAL	**4**	**7**	**4**	**1**					16	3	

TABLA 5

Cueva Lima Lima 1. Recinto, conjuntos en superficie. Número mínimo de especímenes identificados (NISP), número mínimo de elementos (MNE) y porcentaje de supervivencia (% S) por cuadrícula y taxón.

Elemento	Pinnípedos			Cerdo			Mammalia			NISP
	A	B	C	A	B	C	A	B	C	
Cráneo							1		1	2
Húmero			1							1
Fémur					2					2
Tibia					1					1
Metapodios			1							1
Fragmentos indeterminados			1						5	6
NISP total			**3**		**3**		**1**		**6**	**13**

TABLA 6

Cueva Lima Lima 1. Cámara, conjuntos en superficie. Númeromínimo de especímenes identificados (NISP), número mínimo de elementos (MNE) y porcentaje de supervivencia (% S) por cuadrícula y taxón.

Pinnípedos: MNI = 2

Elemento	E3	F2	H3	NISP	MNE	% S.
Cráneo	2			2	1	50
Mándibula	3			3	3	75
Axis	1			1	1	100
Vértebras cervicales	2			2	2	14
Vértebras torácicas	5			5	4	13
Vértebras indeterminadas	2			2	2	20
Escápula	1			1	1	25
Húmero	5			5	3	75
Radio	2			2	2	50
Pelvis	1			1	1	25
Tibia	2			2	2	50
Metapodios	5	1		6	6	15
Falanges	6			6	5	4,4
Dientes	1			1	1	-
sub-total	**40**	**1**		**41**	**34**	
Fragmentos indeterminados	2			2	-	
TOTAL	**42**	**1**		**43**	**34**	

Cerdo: MNI = 2

Cráneo	2			2	1	50
Radio	1			1	1	25
Fémur	2			2	2	50
Calcáneo	1			1	1	25
Astrágalo	1			1	1	25
Metapodios	1			1	1	3,1
Dientes	1	1		2	2	-
TOTAL	**9**	**1**		**10**	**9**	

Vaca: **MNI = 1**

Elemento	E3	F2	H3	NISP	MNE	% S.
Vértebras cervicales	1			1	1	17
Húmero	1			1	1	50
TOTAL	**2**			**2**	**2**	

Mammalia

Cráneo	2			2	1	
Mándibula	1			1	1	
Vértebras cervicales	1			1	1	
Vértebras indeterminadas	3			3	2	
Costillas	8			8	5	
Escápula	1			1	1	
Dientes	1	1		2	2	
sub-total	**17**	**1**		**18**	**13**	
Fragmentos indeterminados	23	1		24		
TOTAL	**40**	**2**		**42**	**13**	

TABLA 7

Cueva Lima Lima 1. Recinto, restos en estratigrafía. Número mínimo de especímenes identificados (NISP), número mínimo de elementos (MNE) y porcentaje de supervivencia (% S) por cuadrícula y taxón.

Pinnípedos: MNI = 3

Elemento	R1	R2	R3	S1	S2	S3	Q1	Q2	NISP	MNE	% S.
Cráneo			1	1					**2**	**1**	**33**
Mandíbula						1			**1**	**1**	**16**
Vértebras cervicales	1								**1**	**1**	**4,7**
Vértebras torácicas						2		1	**3**	**3**	**6,6**
Escápula		1		1		1			**3**	**3**	**50**
Húmero		3			1	1			**5**	**4**	**66**
Radio			1			1			**2**	**1**	**16**
Ulna		1	1						**2**	**1**	**16**
Metacarpos		2							**2**	**2**	**6,6**
Calcaneo						1			**1**	**1**	**16**
Carpianos/tarsianos					1				**1**	**1**	**3,8**
Metapodios					2				**2**	**2**	**3,3**
Falanges		1							**1**	**1**	**0,5**
sub-total	**1**	**8**	**3**	**2**	**4**	**7**		**1**	**26**	**22**	
Fragmentos indet.		1							**1**		
TOTAL	**1**	**9**	**3**	**2**	**4**	**7**		**1**	**27**		

Cerdo: MNI = 1

Cráneo						1			**1**	**1**	**100**
Radio		1							**1**	**1**	**50**
Fémur					1				**1**	**1**	**50**
Dientes		1							**1**	**1**	**-**
TOTAL		**2**			**1**	**1**			**4**	**4**	

Mamífero Grande: MNI = 1

Elemento	R1	R2	R3	S1	S2	S3	Q1	Q2	NISP	MNE	% S.
Escápula						1			**1**	**1**	
Fragmentos indet.			1						**1**		
TOTAL			**1**			**1**			**2**	**1**	

Mammalia:

Cráneo		1							**1**	**1**	
Vértebras indet.		1							**1**	**1**	
Costillas	2	2		3		1			**8**	**8**	
Fragmentos indet.	2		1		1			2	**6**		
TOTAL	4	5	2	3	2	1		2	**16**	**10**	

TABLA 8

Cueva Lima Lima 2. Conjuntos en superficie. Número mínimo de especímenes identificados (NISP), número mínimo de elementos (MNE) y porcentaje de supervivencia (% S) por cuadrícula y taxón.

Pinnípedos: MNI = 7

Elemento	C1	B3	D3	NISP	MNE	% S.
Mandíbula	1			1	1	7,1
Húmero	5	5	4	14	14	100
Radio	1			1	1	7,1
Pelvis			1	1	1	7.1
TOTAL	7	5	5	17	17	
Mamífero Grande: MNI = 1						
Pelvis	1	1		2	1	50
TOTAL	1	1		2	1	
Mammalia: MNI = 1						
Costillas		1		1	1	
Sacro	1			1	1	
Dientes	1			1	1	
Sub-total	2	1		3	3	
Fragmentos indeterminados	12	3	5	20		
TOTAL	14	4	5	23	3	

TABLA 9

Cutler 1. Conjuntos en superficie. Número mínimo de especímenes identificados (NISP), número mínimo de elementos (MNE) y porcentaje de supervivencia (% S) por cuadrícula y taxón.

P. Vietor 1. *Vaca:* MNI = 1

Elemento	NISP	MNE
Húmero	1	1

P. Vietor 2. *Pinnípedos:* MNI = 1

Húmero	1	1
Costilla	1	1
Falange	1	1
TOTAL	3	3

TABLA 10

Punta Vietor 1 y 2. Conjuntos en superficie. Número mínimo de especímenes identificados (NISP), número mínimo de elementos (MNE) por taxón.

Pinnípedos: MNI = 1

Elemento	NISP	MNE
Escápula	1	1
Costilla (mamífero marino)	1	1
TOTAL	2	2

TABLA 11

Sealer 3. Anexo, Conjunto en superficie. Número mínimo de especímenes identificados (NISP), número mínimo de elementos 9MNE) para el taxón Pinnípedos.

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Fishing in the Southern North Sea Region from the 1st to the 16th Century AD: Evidence from Fish Bones

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ABSTRACT: Evidence from archaeological fish bone assemblages from the southern North Sea region of Europe is used to illuminate fishing, fish consumption and fish trade from the 1st to the 16th century AD. The fish species represented in the material indicate a very strong influence from the local fish fauna at almost all sites. The species and size of the fish indicate that several fishing methods have been employed throughout the period studied, including nets, hooks and weirs. A chronological development in fishing, for example, a tendency towards more sea-going fishing, is reflected in the fish bone assemblages in some countries. Evidence from fishing in the Baltic region from the 5th century BC to the 16th century AD is included in the discussion. Indications of fish trade include bones of exotic species (for instance, marine species at inland sites) and an unbalanced representation of skeletal elements (trade with decapitated stockfish or gilless herring). Of particular interest are assemblages which indicate a fish industry, for instance, large-scale processing (removal of gills) of herring in 13th century Denmark.

KEYWORDS: FISH, FISH BONE ASSEMBLAGES, NORTH SEA, IRON AGE, VIKING AGE, MIDDLE AGES, PREHISTORIC FISHING

RESUMEN: Datos procedentes de asociaciones ictioarqueológicas de la región meridional del Mar del Norte en Europa son utilizados para evidenciar la práctica de la pesca así como el consumo y comercio de pescado desde los siglos I al XVI d.C. Las especies de peces representadas en los materiales evidencian una muy fuerte influencia de las faunas locales en prácticamente todos los yacimientos. Tanto la relación de especies como el tamaño de los ejemplares indican que, a lo largo de todo el periodo estudiado, una serie de diferentes métodos de captura, que incluyen redes, garfios y nasas, fué utilizada. Un hito cronológico en las prácticas pesqueras como, por ejemplo, la aparición de la pesca de altura, queda reflejado en las asociaciones ictioarqueológicas recuperadas en diferentes países. En la discusión se incluyen las evidencias en torno a la pesca en la región del Báltico desde el siglo V a.C. al siglo XVI d.C. Las evidencias de comercio de pescado incluyen la presencia de especies exóticas (como suelen ser, por ejemplo, las especies marinas en yacimientos del interior) así como espectros esqueléticos sesgados que implican el transporte de animales decapitados o desprovistos de agallas. De particular interés resultan ser aquellos yacimientos en donde se detecta la existencia de industrias derivadas de la pesca caso de las extracciones a gran escala de agallas de arenque en Dinamarca a lo largo de todo el siglo XIII d.C.

PALABRAS CLAVE: PECES, ASOCIACIONES DE HUESOS DE PESCADO, MAR DEL NORTE, EDAD DEL HIERRO, EDAD VIKINGA, EDAD MEDIA, PESCA PREHISTÓRICA

INTRODUCTION

During archaeological excavations, fish bones are frequently recovered in large quantities. In the present paper evidence from fish bones is used to elucidate fishing, fish consumption and fish trade in the southern North Sea region of Europe during the period from the 1st to the 16th century AD. Fis-

hing in the Baltic region from the 5th century BC to the 16th century AD has been treated in the same way in a previous paper (Enghoff, 1999). During this period, significant developments in fishing tools and techniques took place, including the development of seagoing ships which made fishing on the open sea and long-distance trade possible. This is clearly reflected in the fish bone evidence and in the present review the discussion is based solely on results from fish bone analyses. This is but one approach to the topic. Written sources may add further information, but these are often biased, mostly dealing with special situations, whereas fish bones may be found in any context.

MATERIAL AND METHODS

For the purpose of this review, the southern North Sea region has been defined as comprising the North Sea coast of Denmark and Germany, the Netherlands, Belgium and Eastern England.

The review is based mainly on published studies of large or otherwise significant fish bone assemblages. Many studies based on only a few fish bones have thus been left out of consideration. Others have been left out due to insufficient information about dating.

An original analysis of material from a Danish site (Ribe: Posthuset) is included.

The locations of the reviewed sites are shown in Figure 1. Records from Denmark, Germany, The Netherlands, Belgium and Eastern England are given in Tables 2-6. The entries in Tables 2-6 express numbers of fish bones for each species where such numbers were available. Where absolute numbers were not given, or frequency was indicated as a percentage or by a letter code, entries in the tables are given as presence/absence. This method of presentation was chosen for the sake of uniformity, at the expense of loss of information in some cases. Scales have not been included in the bone counts, instead their presence is recorded in footnotes to Tables 2-6. In the tables, as well as in the sections on individual sites from each country, sites are arranged chronologically, according to the age of their oldest phase. The fish species are divided into marine, migratory and freshwater species in Tables 2-6, within each of these ecological groupings the species are listed systematically (i.e. by taxonomic group).

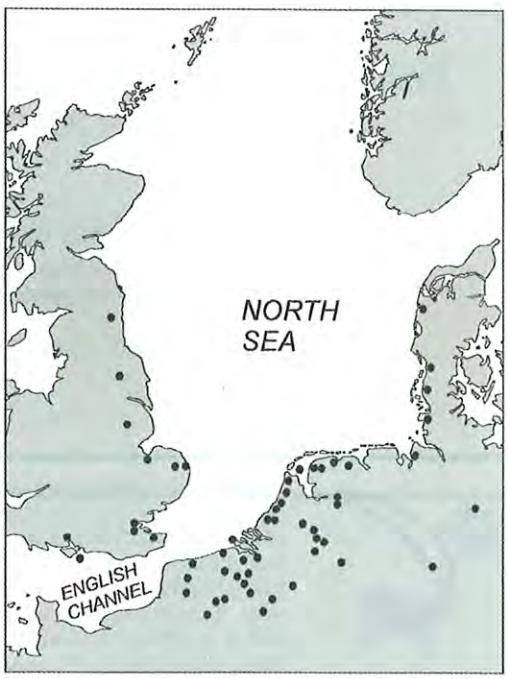

FIGURE 1

Map of the North Sea region of Europe, showing the location of the reviewed sites. See also the more detailed maps for each country (Figures 2, 5-7).

Table 1 summarizes the occurences of fish species in material from the five countries, with English and Latin names according to Whitehead *et al.* (1984-86) for marine species and Blanc *et al.* (1971) for freshwater ones. Since the English names of fish species may be unfamiliar to many readers, the species are arranged alphabetically in Table 1 which thus has the additional function of an English-Latin dictionary.

The fish bone evidence included in the review is obviously of very variable quality, having been influenced by several taphonomic factors, see Enghoff (1999). It is very important to keep in mind taphonomy, including recovery methods, when evidence from different sites is compared and general conclusions are drawn. Often, it is possible to evaluate smaller, less meticulously excavated samples against the background of large, sieved ones.

Since the cultural periods may be differently defined and delimited in the different countries, evidence is as a rule only referred to by century.

Some of the papers dealing with fish bones refer to finds of fishing tools. This information has

	DK	D	NL	B	GB
Allis shad, *Alosa alosa*	.	+	+	.	.
Anglerfish, *Lophius piscatorius*	.	.	.	.	+
Atlantic horsemackerel, *Trachurus trachurus*	+	.	+	.	+
Atlantic mackerel, *Scomber scombrus*	.	.	+	+	+
Ballan wrasse, *Labrus bergylta*	.	.	.	.	+
Barbel, *Barbus barbus*	.	.	+	+	+
Black sea bream, *Spondyliosoma cantharus*	.	.	.	+	.
Bleak, *Alburnus alburnus*	.	.	.	+	.
Blue ling, *Molva dipterygia*	.	.	.	.	.
Brill, *Scophthalmus rhombeus*	.	.	.	.	.
Bullhead, *Cottus gobio*	.	.	.	+	.
Bullrout, *Myoxocephalus scorpius*	.	.	.	+	.
Burbot, *Lota lota*	.	.	+	+	+
Butterfish, *Pholis gunnellus*	.	.	.	.	+
Cartilaginous fishes, Chondrichthyes	.	+	.	+	+
Chub, *Leuciscus cephalus*	.	.	.	+	+
Chub mackerel, *Scomber japonicus*	.	.	+	+	.
Clupeids, Clupeidae	.	.	+	+	+
Cod, *Gadus morhua*	+	+	+	+	+
Common bream, *Abramis brama*	+	.	+	+	+
Common carp, *Cyprinus carpio*	.	.	+	+	+
Common sole, *Solea vulgaris*	+	.	+	+	+
Common stingray, *Dasyatis pastinaca*	.	.	+	.	.
Conger eel, *Conger conger*	.	.	.	.	+
Cyprinids, Cyprinidae	+	+	+	+	+
Dab, *Limanda limanda*	+	.	+	+	+
Dace *Leuciscus leuciscus*	.	.	.	+	+
Dogfish, *Scyliorhinus* sp.	.	.	+	.	+
Eel, *Anguilla anguilla*	+	.	+	+	+
European anchovy, *Engraulis encrasicholus*	.	.	+	+	.
European seabass, *Dicentrarchus labrax*	.	+	+	+	+
Five-bearded rockling, *Ciliata mustela*	.	.	.	.	+
Flatfish, Heterosomata	+	+	+	+	+
Flounder, *Platichthys flesus*	+	+	+	+	+
Gadids, Gadidae	+	+	+	+	+
Garpike, *Belone belone*	.	.	+	+	+
Gobiids, Gobiidae	.	.	.	+	+
Golden grey mullet, *Liza aurata*	.	.	.	.	.
Grayling, *Thymallus thymallus*	.	.	.	.	+
Grey gurnard, *Eutrigla gurnardus*	.	.	.	.	+
Grey mullets, Mugilidae	+	+	+	+	.
Gudgeon, *Gobio gobio*	.	.	.	+	+
Gurnards, Triglidae	.	.	+	+	+
Haddock, *Melanogrammus aeglefinus*	+	+	+	+	+
Hake, *Merluccius merluccius*	.	.	.	.	+
Halibut, *Hippoglossus hippoglossus*	.	.	+	+	+
Herring, *Clupea harengus*	.	.	+	+	+
John Dory, *Zeus faber*	.	.	.	.	+
Lemon sole, *Microstomus kitt*	.	.	.	.	+

TABLE 1

List of the fish taxa (species and a few genera and higher categories) of fish mentioned in the text, and indication of the countries from which they have been recorded in Iron Age to Medieval fish bone assemblages. The list is arranged alphabetically according to the English names, with corresponding Latin names added. The nomenclature follows Whitehead *et al.* (1984-86) for marine species and Blanc *et al.* (1971) for freshwater ones. B = Belgium, D = Germany, DK = Denmark, GB = eastern England, NL = The Netherlands. Species which are not indicated as occurring in any of the countries are included because they occur in the national lists as unconfirmed possibilities (e.g., brill which has been recorded only as "turbot/brill").

	DK	D	NL	B	GB
Ling, *Molva molva*	.	+	+	+	+
Meagre, *Argyrosomus regius*	.	+	+	+	.
Minnow, *Phoxinus phoxinus*	.	.	.	+	.
Nursehound, *Scyliorhinus stellaris*	.	.	.	+	.
Orfe, *Leuciscus idus*	.	+	+	+	.
Perch, *Perca fluviatilis*	+	.	+	+	+
Percids, Percidae	+	.	+	+	+
Pike, *Esox lucius*	+	+	+	+	+
Plaice, *Pleuronectes platessa*	.	+	+	+	+
Pollack, *Pollachius pollachius*	.	.	.	.	+
Ray, *Raja* sp.	.	+	+	+	+
Roach, *Rutilus rutilus*	.	.	+	+	+
Rudd, *Scardinius erythrophthalmus*	.	.	+	+	+
Ruffe, *Gymnocephalus cernua*	.	.	+	+	.
Saithe, *Pollachius virens*	.	+	.	+	+
Salmon, *Salmo salar*	.	+	+	.	+
Salmonids, Salmonidae	+	+	+	+	+
Sandeels, Ammodytidae[1]	.	.	.	+	+
Schneider, *Alburnoides bipunctatus*	.	.	.	+	.
Sea breams, Sparidae	.	.	.	+	+
Shad, *Alosa* sp.	.	+	+	+	+
Sharks, Pleurotremata	.	.	+	+	+
Smallspotted catshark, *Scyliorhinus canicula*	.	.	+	.	.
Smelt, *Osmerus eperlanus*	.	.	+	+	+
Smoothhound, *Mustelus* sp.[2]	.	.	+	.	.
Sole, *Solea* sp.	+	.	+	+	+
Spined loach, *Cobitis taenia*	.	.	.	+	.
Sprat, *Sprattus sprattus*	.	.	.	+	+
Spurdog, *Squalus acanthias*	.	.	.	.	+
Stone loach, *Nomacheilus barbatulus*	.	.	.	+	.
Striped red mullet, *Mullus surmuletus*	.	.	+	.	.
Sturgeon, *Acipenser sturio*	+	+	+	+	+
Tench, *Tinca tinca*	.	.	+	+	+
Thicklip Grey Mullet, *Chelon labrosus*	.	+	+	.	.
Thinlip Grey Mullet, *Liza ramada*	+	.	.	.	.
Thornback Ray, *Raja clavata*	.	+	+	+	+
Three-spined Stickleback, *Gasterosteus aculeatus*	+	.	+	+	+
Topeshark, *Galeorhinus galeus*	.	.	.	+	.
Torsk, *Brosme brosme*	.	.	+	.	.
Trout, *Salmo trutta*	.	.	+	+	+
Tub gurnard, *Trigla lucerna*	.	.	+	+	+
Turbot, *Psetta maxima*	.	+	+	+	+
Twaite shad, *Alosa fallax*	.	.	+	.	.
Wels, *Siluris glanis*	.	+	+	+	.
White bream, *Blicca bjoerkna*	.	.	+	+	.
Whitefish, *Coregonus* sp.	+	.	+	+	+
Whiting, *Merlangius merlangus*	.	.	+	+	+
Wrasses, Labridae	.	.	.	.	+

TABLE 1 (cont.)

List of the fish taxa (species and a few genera and higher categories) of fish mentioned in the text, and indication of the countries from which they have been recorded in Iron Age to Medieval fish bone assemblages. The list is arranged alphabetically according to the English names, with corresponding Latin names added. The nomenclature follows Whitehead *et al.* (1984-86) for marine species and Blanc *et al.* (1971) for freshwater ones. B = Belgium, D = Germany, DK = Denmark, GB = eastern England, NL = The Netherlands. Species which are not indicated as occurring in any of the countries are included because they occur in the national lists as unconfirmed possibilities (e.g., brill which has been recorded only as "turbot/brill").

[1] The Belgian record identified as *Ammodytes tobianus*.

[2] The Dutch records identified as *Mustelus mustelus*.

been taken into account but a systematic search for literature on this subject has not been made. Written sources have in general not been taken into account. The present work is based on fish bone analyses.

DENMARK, INDIVIDUAL SITES

The review is based on already published evidence and on material from one hitherto unpublished site which has been analyzed by the author within the framework of the present project (Ribe: Posthuset).

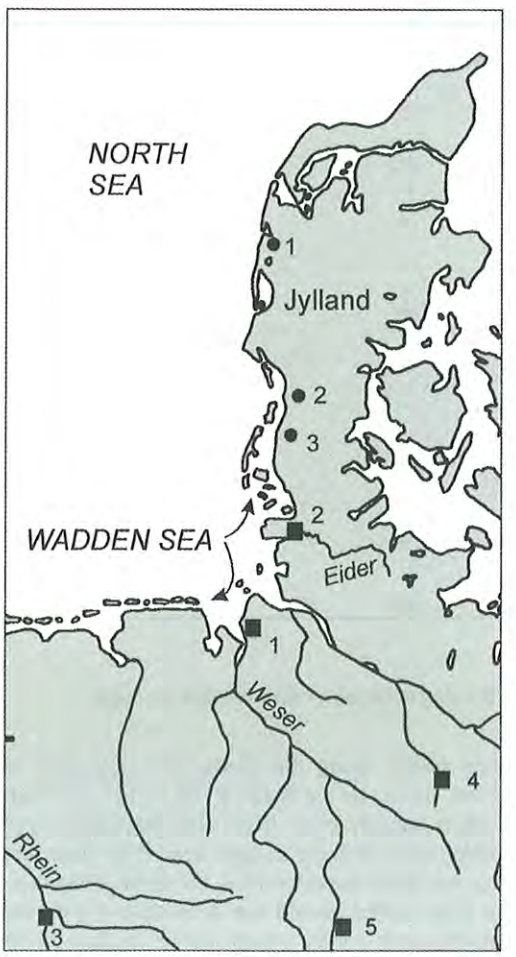

FIGURE 2

Map of the North Sea coast of Denmark and Germany, showing the location of the reviewed sites. Site numbers refer to the section "Denmark, individual sites" (dots) and "Germany, individual sites" (squares).

The site numbers refer to the map, Figure 2. See Table 2 for detailed species lists.

Nørre Fjand (1)

An Iron Age village site at Nissum Fjord, close to the North Sea. The site dates from the 2nd century BC to the 2nd century AD (Pre-Roman to Roman Iron Age) (Hatt, 1957; Rosenlund, 1976). Sieving has not been employed.

A few (25) fish bones of the fresh/brackish water species pike and perch were found. This very small assemblage, which may not be representative, indicates fishing in Nissum Fjord rather than in the North Sea.

Ribe (2)

A marketplace situated on the banks of the river Ribe Å ca. 15 km from the coast of the Wadden sea. The market was founded about AD 705 (dendrochronologically dated). Jensen (1991) assumed that the site was of a seasonal nature, remaining unused during winter, but with a small permanent neighbouring settlement. During the Viking Age, Ribe was an important centre for trade between western Europe and the rest of Scandinavia. The Iron-Viking Age fish bone material covers the period from ca. AD 700-850. In addition there is a smaller Medieval sample, dated to the 12th-13th centuries AD, deriving from two pits. The fish bones were recovered by wet sieving through a 3-4 mm mesh, a few samples through a 2 mm mesh.

The fish bones have been analyzed by Enghoff ("Posthuset", present work, 3163 identified bones). A species list, based on a much smaller amount of material, was produced by Hatting (1991) ("Kunstmuseet etc").

The Iron-Viking Age fish bone material can be subdivided into phases within the interval AD 700-850, but as there are no indications of differences between the phases the entire Iron-Viking Age material is discussed here as one unit. Bones of plaice/flounder/dab dominate the material (66% of the identified bones). Both flounder and dab are represented with certainty (dab is new to the Danish subfossil fauna). Gadids, represented by cod, haddock and ling, constitute 14%. The cod were 37-62 cm long. Gadids are followed in frequency by salmon/trout (7%) and thinlip grey mullet (5%). The find of 144 bones of thinlip grey mullet is remarkable (Figure 3).

Site	Nørre Fjand	Ribe, Kunst-museet etc.	Ribe, Post-huset	Ribe, Post-huset	Trøjborg
Site no. (Fig. 2)	1	2	2	2	3
Age (centuries)	2 BC-2 AD	8 AD	8-9 AD	12-13 AD	14-16 AD
Recovery technique	h	h	s	s	h
MARINE SPECIES					
Smallspotted catshark	-	-	-	1	-
Gadids, total	-	1	419	175	277
Cod	-	-	188	48	4
Haddock	-	1	122	90	273
Ling	-	-	14	1	
Gadids, unspecified	-	-	95	36	-
Atlantic horsemackerel	-	-	5	-	-
Thinlip grey mullet	-	-	144	-	-
Three-spined stickleback	-	-	-	-	-
Flatfishes, total	-	9	1983	5	-
Turbot/Brill	-	-	1	-	-
Flounder	-	-	2	-	-
Dab	-	-	1	-	-
Plaice/Flounder/Dab	-	9	1979	5	-
Common sole	-	-	1	-	-
MIGRATORY SPECIES					
Sturgeon	-	1	-	-	-
Trout/Salmon	-	-	199	-	-
Whitefish	-	-	19	-	-
Eel	-	-	51	-	-
FRESHWATER SPECIES					
Pike	7	-	50	-	-
Cyprinids, total	-	3	90	-	-
Common bream	-	2	1	-	-
Cyprinids, unspecified	-	1	89	-	-
Perch	18	-	21	-	1
TOTAL	25	14	2982	181	278

TABLE 2

Numbers of identified fish bones from Danish North Sea sites. Recovery technique: h = hand-collected, s = sieved.

Thinlip grey mullet is known from only four other Danish sites, all dating from the Mesolithic and the Neolithic, and in each case represented by only a few specimens (Richter, 1987). The Ribe material seems to represent quite a number of individuals representing six phases from AD 700-800. A comparison with recent material indicates that the mullet from Ribe were more than 40 cm long, the majority being more than 50 cm, and one about 70 cm. Today, this species has a southern distribution in Europe and is most frequent south of the English Channel. Only a few individuals have been caught along the coasts of Scandinavia in recent times. In the light of the earlier subfossil finds it appears more likely that the thinlip grey mullet were actually caught near Ribe than that they had been imported from the south. (The thinlip grey mullet should not be confused with the thicklip grey mullet which during the last 20-30 years has become relatively common along Scandinavian coasts).

The relatively large number of bones from salmon/trout is worth noting, since these are normally considered to preserve badly in the soil. Small

FIGURE 3

Bones from thinlip grey mullet found at Ribe, $1^{1/2}\times$ natural size: one opercular (lower left), one parasphenoid, one urohyal and one ceratohyal (upper left) and five vertebrae.

(less than 50 cm), medium-sized and large (much longer than 70 cm) individuals are represented in the material (Figure 4).

Whitefish is also represented. Today, whitefish migrate into all the watercourses running out into the North Sea south of the Limfjord, including Ribe Å.

Summer occupancy of the Iron-Viking Age trading place at Ribe is indicated by the finding of horse mackerel. It is also most likely that the thinlip grey mullet were summer visitors to Denmark.

Sea fishing dominate strongly which is not surprising, considering Ribe's location close to the North Sea.

FIGURE 4

Vertebrae from salmon/trout found at Ribe, 2 × natural size.

The composition of the Iron-Viking Age Ribe material is consistent with the town's geographical location: Flatfish are abundant in the Wadden Sea, thinlip grey mullet migrate into the rivers, and the North Sea has provided an element of gadids. All the species found could have been caught from Ribe. There are almost no bones with cutmarks and there are no instances of conspicuous lack of bones from particular body regions which might suggest the presence of imported fish which had been processed elsewhere.

In contrast to the Iron-Viking Age material, the Medieval bone assemblages from Ribe are very strongly dominated by big gadids including cod, haddock and ling. The size difference in comparison with the Iron-Viking Age gadids is striking, the Medieval cod were very large: 98-122 cm long.

The varied local fishing from Ribe, including fishing in Ribe Å and the Wadden Sea, which was indicated in the Iron-Viking Age material, is not at all evident in the Medieval samples. These rather suggest fishing in the North Sea.

Trøjborg (3)

A Medieval castle in southern Jylland, dated to about AD 1300-1580 (Rosenlund, 1976). The fish bones were hand-collected and almost exclusively represent haddock.

DENMARK, OVERVIEW

In the context of the present paper, Denmark is represented by three sites. A general discussion of fishing in Denmark during the Iron Age, Viking Age and the Middle Ages has been presented in a previous paper (Enghoff, 1999) which also includes fishing and fish consumption at the three Danish North Sea sites.

GERMANY, INDIVIDUAL SITES

The review of the German North Sea sites is based on published results.

The site numbers refer to the map, Figure 2. See Table 3 for detailed species lists.

Feddersen Wierde (1)

A settlement at the mouth of the River Weser where it enters the Wadden Sea/North Sea. The fish

SITE	Feddersen Wierde	Elisenhof	Duisburg	Bodenteich Castle	Plesse Castle	Plesse Castle
Site n° (Figure 2)	1	2	3	4	5	5
Age (centuries)	3 AD	8-13 AD	10-13 AD	13-17 AD	15-16 AD	16-17 AD
Recovery technique	h	h	h	s	h+s	h+s
MARINE SPECIES						
Thornback ray	-	1	-	-	-	-
Ray, unspecified	-	-	-	-	1	-
Herring	-	-	-	4	137	11
Gadids, total	4	230	60	22	61	5
Cod	4	168	41	6	4	1
Haddock	-	45	14	9	-	-
Saithe	-	16	-	2	1?	-
Ling	-	1	3	-	-	-
Torsk	-	-	-	-	5	-
Gadids, unspecified	-	-	2	5	51	4
European seabass	-	1	-	-	-	-
Meagre	3	-	-	-	-	-
Thicklip grey mullet	-	1	-	-	-	-
Flatfishes, total	62	133[1]	1	12	3	4
Turbot	-	1	-	1	-	-
Plaice	7	[2]	-	-	-	2
Flounder	47	51	-	-	-	-
Plaice/Flounder/Dab	8	81	1	-	-	-
Flatfishes, unspecified	-	-	-	11	3	2
MIGRATORY SPECIES						
Sturgeon	215	120	-	-	-	-
Allis shad	5	-	-	-	-	-
Shad	[3]	-	4	-	-	-
Salmon	-	-	1	-	-	-
Trout/Salmon	3[4]	-	1	5	12	-
Whitefish	-	-	-	1	-	-
Eel	-	-	-	2	24	1
FRESHWATER SPECIES						
Pike	-	1	-	12	71	10
Cyprinids, total	-	-	19	37	420	49
Common carp	-	-	-	3	64	14
Gudgeon	-	-	-	-	3	-
Tench	-	-	-	-	1	-
Dace	-	-	-	-	1?	-
Chub	-	-	-	-	5	1
Orfe	-	-	7	-	-	-
Roach	-	-	-	9	11	1
Common bream	-	-	-	4	9	1
[HE1] Cyprinids unspecified	-	-	12	21	326	32
Wels	-	8	-	-	-	-
Burbot	-	-	-	1	-	-
Perch	-	-	-	16	56	2
Ruffe	-	-	-	-	3	1
TOTAL	292	495	86	112	788	83

TABLE 3

Numberss of identified fishbones from German sites. Recovery technique: h = hand-collected, s = sieved, ? = unknown.

[1] excluding one complete skeleton.

[2] one complete skeleton.

[3] 12,000 scales.

[4] excluding 1200 scales.

bone material is dated to the 3rd century AD and was recovered by hand-collection (Heinrich, 1991).

The most frequently represented species is the sturgeon. On the basis of the spectrum of fish species, which includes shad, Heinrich (1991) concluded that most of the fishing took place close to the settlement, for example, in the mouth of the Weser. A small number of vertebrae from very large cod (total length 107 cm and 125 cm) indicates, however, fishing in the North Sea. The presence of meagre is notable, this species being nowadays a rare visitor to the area.

Elisenhof (2)

A North Sea village situated on the estuary of the River Eider. The excavated material covers the 8th-13th centuries AD and was recovered by hand-collection (Heinrich, 1985, 1994a).

Most of the fish bones are from cod, sturgeon and plaice/flounder/dab. Considering the recovery technique small fish must, however, be regarded as under-represented. Freshwater fishing seems not to have played a major role, except for sturgeon which is thought to have been caught in connection with its spawning in the Eider. The presence of wels, nowadays extinct in the area, is also worth noting. Apart from this local fishing in the Eider estuary and the Wadden Sea, the inhabitants appear also to have fished in the North Sea. This is indicated by the presence of haddock, saithe, ling and large cod (95-130 cm). Heinrich (1985, 1994a) believed that the inhabitants of Elisenhof fished for their own sustenance, and that fishing was of great importance.

Duisburg (3)

A Medieval town, situated on the River Rhein, ca. 180 km from the sea. The fish bone material is dated to the 10th-13th centuries AD; 78 of the 86 bones are, however, from the 13th century. The bones were hand-collected and are therefore not regarded as representative (Heinrich, 1992). Most of the bones are from gadids, especially cod, but also haddock and ling. Heinrich (1992) thought that all the gadids were imported to Duisburg in the form of stockfish, because head bones are largely absent. The sizes of the fish also agree with this interpretation: cod 85-120 cm, haddock 40-70 cm and ling 130-140 cm. All haddock bones are from the 13th century. Shad, trout/salmon and cyprinids, including chub, also indicate local fishing.

Bodenteich (4)

A castle situated ca. 150 km from the North Sea coast. Fish bones were obtained by sieving and were studied by Heinrich (1994b, 1999a). The material is referable to five periods of which three (13th-17th centuries AD) are considered here. A few fish bones from the 9th-12th centuries AD and a sample from the 17th-18th centuries AD are omitted. In the light of the small numbers of bones and the lack of any difference between the three included periods, these are combined in Table 3.

Despite the long distance to the sea, the material contains both freshwater, migratory and marine fish. Whereas the former may have been caught locally, the marine species indicate long-distance transport. The gadids are almost exclusively represented by skeleton elements indicating stockfish.

Plesse (5)

A castle situated ca. 250 km from the North Sea coast. Fish bones were obtained by hand-collection and sieving of material from the courtyard and are referable to two periods, 15th-16th and 16th-17th centuries AD. They were studied by Heinrich (1994b).

The composition of the Plesse material is similar to that at Bodentiech (see above). Also in Plesse, the gadids seems to have been stockfish. The presence of torsk in particular indicates long-distance transport, torsk being an Arcto-Atlantic species.

GERMANY, OVERVIEW

The dates for the German assemblages lie within the interval from the 3rd to the 17th centuries AD.

Local influences on North Sea fishing in Germany

The Germanic village Feddersen Wierde is situated close to the North Sea and is considerably older (3rd century AD) than the other German sites reviewed here and previously (Enghoff, 1999). In spite of this, the fishing was very varied. It apparently took place mostly in the Weser estuary, but also in the Wadden Sea and possibly (as indicated by very large cod) in the open North Sea as well. Sturgeon was so common at Feddersen Wierde that its bones were used for toolmaking. A very

local element is constituted by meagre which is common in southern Europe and is often encountered in estuaries (Curry-Lindahl, 1985); at Feddersen Wierde it was probably caught in the Weser estuary.

The material from the coastal village of Elisenhof is dominated by marine species including haddock, saithe, ling and large cod which could only have been caught in the North Sea. A number (>16) of large gorges have been found, these may have been used for catching large gadids. Heinrich (1985, 1994a) regarded Elisenhof as a fishing village. In addition to the North Sea, Elisenhof's fishermen seem to have worked in the Wadden Sea and the Eider estuary. The local character of the Elisenhof fishing is underlined by the element of southern marine species like European seabass and thicklip grey mullet.

The typically marine character of the fishing from Elisenhof resembles that seen in the much older site of Feddersen Wierde.

Remains of fishing tools from German sites

More than 16 large gorges (see above) and a net floater were found at Elisenhof.

Indications of fish trade in Germany

Most of the fish bones from the North Sea site of Elisenhof are from the oldest phase and are thus contemporaneous with the nearby town of Haithabu which faces the Baltic coast (Enghoff, 1999). Material from the two sites is, however, very different, and Heinrich (1985, 1994a) believed that there was no export of fish from the fishing village, Elisenhof to the trading centre Haithabu.

Large gadids and other marine fish were imported to Duisburg, Bodenteich and Plesse 150-250 kilometres inland from the North Sea.

THE NETHERLANDS, INDIVIDUAL SITES

The review is based on published evidence.

The site numbers refer to the map, Figure 5. See Table 4 for detailed species lists.

Groenman-van Waateringe & van Wijngaarden-Bakker (1990) gave a summary of common fish species found at (pre-) urban and rural Medieval Dutch sites.

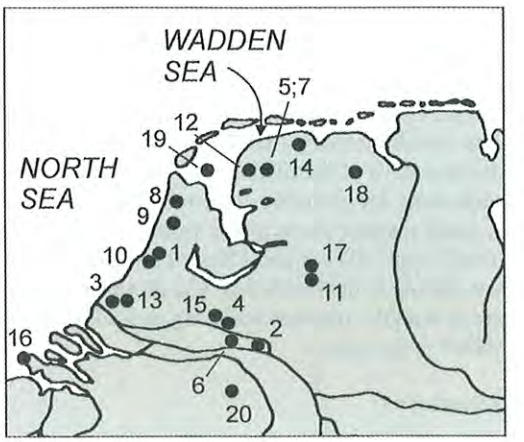

FIGURE 5

Map of the Netherlands, showing the location of the reviewed sites. Site numbers refer to the section "The Netherlands, individual sites".

Velsen 1 and Velsen 2 (1)

Two Roman military settlements situated near the coast, on the bank of the River Oer IJ, a former tributary of the Rhein. The fish bones excavated at Velsen are dated to the first half of the 1st century AD. Conditions for the preservation of fish bones at the site are good. The fish remains from Velsen 1 are from a harbour basin and two wells and were excavated partly by hand, partly with the aid of 5 mm mesh sieves. The fish remains from Velsen 2 were hand-collected, they were studied by Brinkhuizen (1989a).

The list of species in the Velsen material is very long and includes marine, migratory and freshwater fish. Among the marine species, plaice/flounder/dab, grey mullet and cod were the most important, whereas the most important freshwater species were perch, cyprinids and pike. An exotic element consisting of meagre and chub mackerel is noteworthy. The cod were large (about 1 m) and are represented by bones from both head and trunk.

Nijmegen, Canisiuscollege (2)

Hoek & Brinkhuizen (1990) presented a preliminary analysis of fish bones from a pit found during excavations of a Roman site in the area of the former Canisiuscollege in Nijmegen, ca. 110 km from the North Sea coast. The sample was sieved and is dated to ca. 100 AD. At least twelve

Site	Velsen 1	Velsen 2	Nijmegen, Canisius-college	Valken-burg 1	Valken-burg 2	Dorestad	Nijehove
Site no. (Fig. 6)	1	1	2	3	3	4	5
Age (centuries)	1 AD	1 AD	1 AD	1-3 AD	1-3 AD	8-9 AD	9 AD
Recovery technique	h+s	h	s	?	?	h+s	h
MARINE SPECIES							
Smallspotted catshark	1	-	-	-	-	-	-
Smoothhound	1	-	-	-	15[1]	-	-
Common stingray	1	-	-	-	-	-	-
Thornback ray	4	-	-	-	2	-	-
Ray, unspecified	-	-	-	-	-	-	-
Herring	-	-	-	-	-	72	-
Herring/Sprat	-	-	-	-	-	-	-
European anchovy	-	-	-	-	-	-	-
Garfish	-	-	-	-	1	-	-
Gadids, total	63	1	-	+	+	5	+
Cod	55	-	-	+	-	-	+
Haddock	3	1	-	-	-	1	-
Whiting	5	-	-	-	+	-	+
Ling	-	-	-	-	-	-	-
Ling/Blue ling	-	-	-	-	-	-	-
Torsk	-	-	-	-	-	-	-
Gadids, unspecified	-	-	-	-	-	4	-
European sea bass	3	-	-	-	-	-	-
Atlantic horse-mackerel	1	-	-	-	-	-	-
Meagre	1	-	-	-	-	-	-
Striped red mullet	1	-	-	-	-	-	-
Thicklip grey mullet	38	-	-	-	+	-	-
Thinlip/Golden grey mullet	45	3	-	+	-	-	-
Grey mullets, unspecified	107	1	-	-	-	-	-
Atlantic mackerel	-	-	-	-	-	-	-
Chub mackerel	1	-	+	-	-	-	-
Tub gurnard	10	-	-	-	-	-	-
Three-spined stickleback	-	-	-	-	+	-	-
Flatfishes, total	344	2	-	+	>1000	57	+
Turbot	5	-	-	-	-	1	-
Halibut	-	-	-	-	-	-	-
Dab	2	-	-	-	-	-	-
Plaice	1	-	-	-	-	24	-
Flounder	30	-	-	-	+	17	-
Plaice/Flounder/Dab	306	2	-	+	-	15	+
Common sole	-	-	-	-	-	-	-
Flatfishes, unspecified	-	-	-	-	-	-	-

TABLE 4

Numbers of identified fish bones from Dutch sites. Recovery technique: h = hand-collected, s = sieved, ? = unknown.

[1] recorded as spurdog by Laarman (1986), see text.

Site	Velsen 1	Velsen 2	Nijmegen, Canisius-college	Valkenburg 1	Valkenburg 2	Dorestad	Nijehove
Site no.	1	1	2	3	3	4	5
Age (centuries)	1 AD	1 AD	1 AD	1-3 AD	1-3 AD	8-9 AD	9 AD
Recovery technique	h+s	h	s	?	?	h+s	h
MIGRATORY SPECIES							
Sturgeon	5	-	+	+	+	22	-
Allis shad	-	-	+	-	-	21	-
Twaite shad	4	-	-	-	>1000	-	-
Shad	1	-	-	-	-	-	-
Salmon	-	-	+	-	-	34	-
Trout	-	-	-	-	-	-	-
Salmon/Trout	5	7	-	-	+	-	-
Whitefish	6	-	-	-	-	1	-
Smelt	-	-	-	-	-	-	+
Eel	98	2	+	-	+	265	+
FRESHWATER SPECIES							
Pike	411	13	+	+	+	105	-
Cyprinids, total	743	8	+	-	+	471	-
Common carp	-	-	-	-	-	-	-
Barbel	-	-	+	-	-	1	-
Tench	7	-	+	-	-	1	-
Orfe	-	-	+	-	-	2	-
Roach	8	-	+	-	-	8	-
Rudd	4	-	-	-	-	-	-
Common Bream	258	5	+	-	+	42	-
White bream	11	-	-	-	-	1	-
Cyprinids, unspecified	455[2]	3	-	-	-	416	-
Wels	172	27	+	+	1	1	-
Burbot	-	-	-	-	-	2	-
Perch	663[3]	3	+	-	-	272	+
Ruffe	19	-	-	-	-	-	-
TOTAL	2746	67	+	+	>10,000	1328	+

TABLE 4 (cont.)

Numbers of identified fish bones from Dutch sites. Recovery technique: h = hand-collected, s = sieved, ? = unknown.

[2] excluding 9 scales.

[3] excluding 78 scales.

Site	Nijehove	Tiel	Leeuwarden I	Leeuwarden II	Schagen	Alkmaar	Haarlem, Jansstraat 46
Site no. (Fig. 6)	5	6	7	7	8	9	10
Age (centuries)	10-11 AD	9-12 AD	11-14 AD	11-14 AD	12-13 AD	12-14 AD	12-18 AD
Recovery technique	s	h+s	h	h	h+s	?	?
MARINE SPECIES							
Smallspotted catshark	-	-	-	-	-	-	-
Smoothhound	-	-	-	-	-	-	-
Common stingray	-	-	-	-	-	-	-
Thornback ray	-	-	-	-	-	-	-
Ray, unspecified	-	-	-	-	-	-	-
Herring	-	-	-	-	-	-	77
Herring/Sprat	+	-	-	-	-	-	-
European anchovy	+	-	-	-	-	-	-
Garfish	-	-	-	3	-	-	-
Gadids, total	+	-	73	71	-	10	138
Cod	+	-	42	35	-	8	17
Haddock	-	-	7	11	-	2	10
Whiting	+	-	-	4	-	-	-
Ling	-	-	1	-	-	-	-
Ling/Blue ling	-	-	-	-	-	-	-
Torsk	-	-	-	-	-	-	-
Gadids, unspecified	-	-	23	21	-	-	-
European sea bass	-	-	-	1	-	-	-
Atlantic horse-mackerel	-	-	-	-	-	-	-
Meagre	-	-	-	-	-	-	-
Striped red mullet	-	-	-	-	-	-	-
Thicklip grey mullet	-	-	-	-	-	-	-
Thinlip/Golden grey mullet	-	-	-	-	-	-	-
Grey mullets, unspecified	-	-	-	1	-	-	-
Atlantic mackerel	-	-	-	-	-	-	-
Chub mackerel	-	-	-	-	-	-	-
Tub gurnard	-	-	-	-	-	5	-
Three-spined stickleback	-	-	-	-	5	-	-
Flatfishes, total	+	1	18	52	52	4	16
Turbot	-	-	-	-	1	-	-
Halibut	-	-	-	-	-	-	-
Dab	-	-	-	-	-	-	-
Plaice	-	1	1	2	-	-	3
Flounder	-	-	-	-	-	-	3
Plaice/Flounder/Dab	+	-	16	46	51	-	-
Common sole	-	-	1	4	-	-	-
Flatfishes, unspecified	-	-	-	-	-	4	10

TABLE 4 (cont.)

Numbers of identified fish bones from Dutch sites. Recovery technique: h = hand-collected, s = sieved, ? = unknown.

Site	Nijehove	Tiel	Leeuwarden I	Leeuwarden II	Schagen	Alkmaar	Haarlem, Jansstraat 46
Site no.	5	6	7	7	8	9	10
Age (centuries)	10-11 AD	9-12 AD	11-14 AD	11-14 AD	12-13 AD	12-14 AD	12-18 AD
Recovery technique	s	h+s	h	h	h+s	?	?
MIGRATORY SPECIES							
Sturgeon	-	12	-	-	-	-	-
Allis shad	-	-	-	-	-	-	-
Twaite shad	-	-	-	-	-	-	-
Shad	-	-	-	-	-	-	-
Salmon	-	-	-	-	-	-	-
Trout	-	-	-	-	-	-	-
Salmon/Trout	-	-	-	-	-	-	-
Whitefish	-	-	-	-	-	-	-
Smelt	+	-	-	-	-	-	-
Eel	+	-	-	-	7	-	37
FRESHWATER SPECIES							
Pike	-	-	-	-	-	-	-
Cyprinids, total	-	1	4	2	-	-	104
Common carp	-	-	2	-	-	-	-
Barbel	-	-	-	-	-	-	-
Tench	-	-	-	-	-	-	-
Orfe	-	-	-	-	-	-	-
Roach	-	-	-	-	-	-	-
Rudd	-	-	-	-	-	-	-
Common Bream	-	-	-	1	-	-	-
White bream	-	-	-	-	-	-	-
Cyprinids, unspecified	-	1	2	1	-	-	104
Wels	-	1	-	-	-	1	-
Burbot	-	-	-	-	-	-	-
Perch	-	1	1	1	-	-	100[4]
Ruffe	-	-	-	-	-	-	-
TOTAL	+	16	96	131	64	20	472

TABLE 4 (cont.)

Numbers of identified fish bones from Dutch sites. Recovery technique: h = hand-collected, s = sieved, ? = unknown.

[4] mostly scales.

Site	Haarlem, Brink-mann-Complex	Voorst	Zweins	Leiden	Dokkum	Utrecht	Valkenisse
Site no. (Fig. 6)	10	11	12	13	14	15	16
Age (centuries)	13-15 AD	13-14 AD	13-14 AD	14	14-16 AD	15 AD	15 AD
Recovery technique	s	?	h	h+s	?	?	s
MARINE SPECIES							
Smallspotted catshark	-	-	-	-	-	-	-
Smoothhound	-	-	-	-	-	-	-
Common stingray	-	-	-	-	-	-	-
Thornback ray	-	-	-	-	-	-	-
Ray, unspecified	+	-	-	9	-	-	-
Herring	+	4	-	7	-	+	13
Herring/Sprat	-	-	-	-	-	-	-
European anchovy	-	-	-	-	-	-	-
Garfish	-	-	-	-	-	-	-
Gadids, total	+	6	-	145	+	+	1
Cod	+	6	-	77	+	+	-
Haddock	+	-	-	49	-	-	-
Whiting	+	-	-	19	-	-	1
Ling	-	-	-	-	-	-	-
Ling/Blue ling	-	-	-	-	-	-	-
Torsk	-	-	-	-	-	-	-
Gadids, unspecified	-	-	-	-	-	-	-
European sea bass	-	-	-	-	-	-	-
Atlantic horse-mackerel	+	-	-	-	-	-	-
Meagre	-	-	-	-	-	-	-
Striped red mullet	-	-	-	-	-	-	-
Thicklip grey mullet	-	-	-	-	-	-	-
Thinlip/Golden grey mullet	-	-	-	-	-	-	-
Grey mullets, unspecified	-	-	-	-	-	-	-
Atlantic mackerel	-	-	-	-	-	-	-
Chub mackerel	-	-	-	-	-	-	-
Tub gurnard	-	-	-	2	-	-	-
Three-spined stickleback	+	7	-	-	-	-	-
Flatfishes, total	+	-	-	138	+	+	1
Turbot	-	-	-	-	-	-	-
Halibut	-	-	-	-	-	-	-
Dab	-	-	-	-	-	-	-
Plaice	+	-	-	-	-	+	-
Flounder	-	-	-	-	-	-	-
Plaice/Flounder/Dab	-	-	-	-	-	-	-
Common sole	-	-	-	-	-	-	-
Flatfishes, unspecified	+	-	-	138	+	-	1

TABLE 4 (cont.)

Numbers of identified fish bones from Dutch sites. Recovery technique: h = hand-collected, s = sieved, ? = unknown.

Site	Haarlem, Brink-mann-Complex	Voorst	Zweins	Leiden	Dokkum	Utrecht	Valkenisse
Site no.	10	11	12	13	14	15	16
Age (centuries)	13-15 AD	13-14 AD	13-14 AD	14	14-16 AD	15 AD	15 AD
Recovery technique	s	?	h	h+s	?	?	s
MIGRATORY SPECIES							
Sturgeon	-	-	-	-	-	-	-
Allis shad	-	-	-	-	-	-	-
Twaite shad	-	-	-	-	-	-	-
Shad	-	-	-	-	-	-	-
Salmon	-	4	-	[5] -	-	-	-
Trout	-	-	-	-	-	-	-
Salmon/Trout	-	-	-	-	-	-	-
Whitefish	-	-	-	-	-	-	-
Smelt	-	-	-	1	-	-	-
Eel	+	12	-	14	-	+	8
FRESHWATER SPECIES							
Pike	-	5	1	4	-	-	-
Cyprinids, total	-	38	71	68	-	+	5
Common carp	-	3	1	+	-	-	-
Barbel	-	-	-	-	-	-	-
Tench	-	-	-	-	-	-	-
Orfe	-	-	-	-	-	-	-
Roach	-	6	70	-	-	+	-
Rudd	-	-	-	-	-	-	-
Common Bream	+	1	-	+	-	-	-
White bream	-	-	-	-	-	-	-
Cyprinids, unspecified	+	28	-	+	-	-	5
Wels	-	-	-	-	-	-	-
Burbot	-	-	-	-	-	-	-
Perch	+	[6] 6	-	49	-	+	-
Ruffe	-	1	-	-	-	+	-
TOTAL	+	83	72	437	+	+	28

TABLE 4 (cont.)

Numbers of identified fish bones from Dutch sites. Recovery technique: h = hand-collected, s = sieved, ? = unknown.

[5] 3 scales.

[6] excluding scales.

Site	Deventer	Groningen Raamstadt	Groningen Katten-diep	Scheurrak SO1 Barrel 1	Scheurrak SO1 Barrel 2	Eindhoven
Site no. (Fig. 6)	17	18	18	19	19	20
Age (centuries)	15 AD	16 AD	16 AD	16 AD	16 AD	16-17 AD
Recovery technique	s	?	s	-	-	h+s
MARINE SPECIES						
Smallspotted catshark	-	-	-	-	-	-
Smoothhound	-	-	-	-	-	-
Common stingray	-	-	-	-	-	-
Thornback ray	-	-	4	-	-	54
Ray, unspecified	-	-	2	-	-	-
Herring	-	-	53	-	-	-
Herring/Sprat	-	-	-	-	-	-
European anchovy	-	-	-	-	-	-
Garfish	-	-	-	-	-	-
Gadids, total	21	+	543	4068	2052	417
Cod	16	+	12	4068	142	344
Haddock	-	+	64	-	-	38
Whiting	5	-	22	-	-	35
Ling	-	-	-	-	-	-
Ling/Blue ling	-	-	-	-	6	-
Torsk	-	-	-	-	27	-
Gadids, unspecified	-	-	445	-	1877	-
European sea bass	-	-	-	-	-	-
Atlantic horse-mackerel	-	-	-	-	-	-
Meagre	-	-	-	-	-	-
Striped red mullet	-	-	-	-	-	-
Thicklip grey mullet	-	-	-	-	-	-
Thinlip/Golden grey mullet	-	-	-	-	-	-
Grey mullets, unspecified	-	-	-	-	-	-
Atlantic mackerel	-	-	-	-	-	-
Chub mackerel	-	-	-	-	-	-
Tub gurnard	-	-	-	-	-	-
Three-spined stickleback	-	-	-	-	-	-
Flatfishes, total	1	+	497	-	-	277
Turbot	-	-	4	-	-	5
Halibut	-	-	-	-	-	-
Dab	-	-	1	-	-	-
Plaice	-	-	10	-	-	3
Flounder	-	-	-	-	-	7
Plaice/Flounder/Dab	-	-	482	-	-	-
Common sole	-	-	-	-	-	-
Flatfishes, unspecified	1	+	-	-	-	262

TABLE 4 (cont.)

Numbers of identified fish bones from Dutch sites. Recovery technique: h = hand-collected, s = sieved, ? = unknown.

Site	Deventer	Groningen Raamstadt	Groningen Katten-diep	Scheurrak SO1 Barrel 1	Scheurrak SO1 Barrel 2	Eindhoven
Site no.	17	18	18	19	19	20
Age (centuries)	15 AD	16 AD	16 AD	16 AD	16 AD	16-17 AD
Recovery technique	s	?	s	-	-	h+s
MIGRATORY SPECIES						
Sturgeon	-	-	-	-	-	2
Allis shad	-	-	-	-	-	-
Twaite shad	-	-	-	-	-	-
Shad	-	-	2	-	-	-
Salmon	-	-	-	-	-	-
Trout	-	-	-	-	-	-
Salmon/Trout	-	-	5	-	-	8
Whitefish	-	-	-	-	-	-
Smelt	-	-	4	-	-	-
Eel	205	-	214	-	-	90
FRESHWATER SPECIES						
Pike	-	-	11	-	-	54
Cyprinids, total	1403	-	53	-	-	295
Common carp	-	-	-	-	-	16
Barbel	-	-	-	-	-	-
Tench	-	-	-	-	-	1
Orfe	-	-	-	-	-	-
Roach	-	-	11	-	-	1
Rudd	-	-	1	-	-	-
Common Bream	-	-	3	-	-	1
White bream	-	-	1	-	-	-
Cyprinids, unspecified	1403	-	37	-	-	276
Wels	-	-	-	-	-	-
Burbot	-	-	-	-	-	-
Perch	-	-	2	-	-	43
Ruffe	-	-	-	-	-	-
TOTAL	1630	+	1386	4068	2052	1240

TABLE 4 (cont.)

Numbers of identified fish bones from Dutch sites. Recovery technique: h = hand-collected, s = sieved, ? = unknown.

species of migratory and freshwater fish are present, including sturgeon and wels. Some vertebrae of salmon were cleft, and of the allis shad only remains of the head were found. Therefore, Hoek & Brinkhuizen (1990) interpreted the fish remains as refuse from processing of fish.

Vanderhoeven *et al.* (1994) mentioned a find of chub mackerel in a new, as yet unpublished sample from the same site. Lauwerier (1993) reported on further finds of chub mackerel in another Roman site, Kopse Hof, in Nijmegen: a concentration of bones interpreted as remains of imported fish sauce, as well as remains of three complete specimens which were regarded as having been imported in a salted condition. A sample from fourth century AD Nijmegen revealed another exotic species, namely barracuda, which is also regarded as having been imported (Lauwerier, 1988).

Valkenburg (3)

A Roman castellum situated near the coast. Well-preserved fish bone material dated to the 1st-3rd centuries AD has been recovered from this site. Neither the recovery technique, nor the number of identified bones, was given by Brinkhuizen (1979a) who considered that the recovery technique was responsible for the shorter list of species from Valkenburg ("Valkenburg 1" in Table 4), compared with contemporaneous and similarly situated Velsen.

Laarman (1986) gave a preliminary report on a very big, partly very well-preserved fish bone assemblage from Valkenburg, also from the Roman castellum (Valkenburg 2" in Table 4). The material includes several sieved samples, e.g., a barrel (*dolium*) with more than ten thousand fish bones. The barrel mostly contained remains of flatfishes, but sturgeon and pike were also identified. Flatfishes are in general the commonest type of fish in the material. Of the remaining species on Laarman's list, twaite shad is one of the most frequent (more than a thousand bones). Laarman (1986) reported spurdog from this material; however, his fig. 3 which is said to show spurdog vertebra, rather suggests smoothhound. Migratory species constitute a very large fraction of the material.

Dorestad (4)

A town about 70 km from the North Sea coast situated at a fork from which the Rivers Rhein and Lek continue their flow westwards. Dorestad dates approximately from AD 700-850, at which time it was a major shipping port, trading for example with Germany, England and Scandinavia. Fish bone material was recovered at Dorestad, partly by hand-collecting, partly by sieving through three sieves with meshes of 10 mm, 4 mm and 1.5 mm respectively. The fish bones are from settlements partly at the harbour, partly in the farming area (Prummel, 1978, 1982, 1983). Prummel (1983) analyzed the material in great detail but could demonstrate no differences in fish consumption between the harbour and the agrarian areas. In Table 4, only the total numbers of identified fish bones from excavations post-1967 are therefore given. Older excavations (before 1967, not shown in the table) yielded unrecorded numbers of bones of sturgeon, pike and wels. As can be seen from the species list, most of the fish bones are from freshwater fish, but many are also from migratory species. All these species could have been caught in rivers in the vicinity, probably even in Dorestad itself. In addition, bones of marine species: herring, haddock, unspecified gadids and flatfish were found.

Nijehove (5)

One of the three small settlements which later fused and became Leeuwarden on the Wadden Sea (see below). There are two fish bone assemblages from Nijehove, one was hand-collected and dated to the 9th century AD, the other was sieved through a 0.5 mm mesh and dated to the 10th-11th centuries AD. All the species present, except perch, are common in the Wadden Sea (Brinkhuizen, 1988a).

Tiel (6)

A small sample of fish bones were hand-collected and sieved from kitchen refuse, dated to the 9th-12th centuries AD, from Tiel, ca. 80 km from the North Sea coast. Most of the fish bones are from migratory (sturgeon) and freshwater species (including wels) but plaice is also represented (Lauwerier & Villari, 1995).

Leeuwarden (7)

A town situated about 15 km from the Wadden Sea. Fish bones were hand-collected at two sites in Medieval Leeuwarden, I: Sct. Jacobsstraat, II: Speelmanstraat. Both are from occupation layers

dating from the 11th-14th centuries AD, but may be contaminated with material from the 15th-16th centuries. The majority of the fish bones are from marine species, especially gadids and flatfish. The former are represented by cod, haddock, ling and whiting. Five parasphenoid bones are from ca. 1 m long cod. Several of these have been split longitudinally or carry longitudinal cutmarks. Brinkhuizen (1983) interpreted this as an indication that remains of stockfish are involved. The presence of common carp is also noteworthy.

Schagen (8)

A site which during the 12th-13th centuries was situated close to a flat tidal landscape. A small amount of fish bone material, dated to the 12th-13th centuries AD, was excavated at Schagen in 1980. Bones were both hand-collected and recovered by sieving. Most of the fish bones are from small flounder or plaice which must have been very common locally (Prummel, 1989).

Alkmaar (9)

A town ca. 7 km from the North Sea coast. A small amount of fish bone material from 12th-14th century AD occupation layers has been excavated from Medieval Alkmaar. The recovery technique is unknown. All fish bones are from marine species, except one bone of wels. The cod bones are from individuals about 90 cm long and only represent the head. Haddock is represented by two shoulder girdle bones (cleithrum) (Clason & Brinkhuizen, 1978).

Haarlem, Jansstraat 46 (10)

Haarlem is situated ca. 10 km from the sea coast. Fishbones were recovered during excavations in Jansstraat 46. The material dates from the 12th-18th (mostly 14th-17th) centuries AD. Most of the fish bones derive from a soil sample taken in a pit. They were studied by Seeman (1984).

Marine and freshwater species are about equally represented in the material, cf. the following site.

Haarlem, Brinkmann-Complex (10)

During excavations in the Brinkmann-Complex in Haarlem, several soil samples dated to the 13th-15th century were sieved and yielded a material of fishbones. The bones were identified by P. Kelk and published by van Wijngaarden-Bakker (1980a).

The fish bones represent marine, migratory and freshwater species. The marine species may have been imported from the nearby coast; the freshwater ones may have been caught in the vicinity of Haarlem.

Voorst (11)

Fish bones were obtained from a sample taken in a well in the castle of Voorst, ca. 110 from the North Sea coast. The technique of recovery is not indicated. Freshwater fish, especially cyprinids, dominate the rather small material which dates from the 13th-14th centuries AD (Ijzereef, 1983).

Zweins (12)

Well-preserved faunal remains including fish bones were hand-collected in material dated from 1250-1400 AD excavated from the moat surrounding a "stinswier" (a small mound of about 3 metres height, with a square towerlike castle on top, K. Bosma pers. comm.) near Zweins in Friesland, ca. 6 km from the Waddensea coast. Fish bones were identified by D. Brinkhuizen and published by van Maanen & Vaandrager (1988).

Few fish bones were found, most of them are from roach and may represent one individual only. The find of carp is among the earliest known from the Netherlands.

Leiden (13)

Leiden lies less than 10 km from the North Sea coast. Fish bones were hand-collected and sieved from a soil sample taken under the modern fish market. The sample was dated to the 14th century AD. Fish bones were studied by P. Vos-Kelk and publihed by van Wijngaarden-Bakker (1980b).

Most of the fish bones are from marine fishes, especially gadids and flatfishes, but there is a considerable element of freshwater fishes and a few migratory ones as well.

Dokkum (14), Utrecht (15) and Groningen, Raamstadt (18)

Information on fish remains from these three sites was taken from table 1 in Brinkhuizen

(1979a). The fish remains from Dokkum (ca. 10 km from the Wadden Sea) came from a 14th-16th century AD refuse pit, those from Utrecht (ca. 50 km from the North Sea) from the Catharijne Convent (15th century and later), and those from Groningen (Raamstadt, ca. 25 km from the Wadden Sea) from around the foundations of a castle which was demolished in 1577. Recovery techniques and numbers of identified bones are unknown.

Valkenisse (16)

Excavations in remnants of a castle from the early 15th century situated on a peninsula at the mouth of the estuary of the river Schelde produced a small assemblage of fish bones. The fish bones were recovered by sieving of samples of a latrine pit through a 2 mm mesh. Marine, migratory and freshwater fish are represented in the sample (Lauwerier & Laarman, 1996).

Deventer (17)

A sieved sample of fish bones has been taken in a refuse pit, dated to the 15th century AD, in Deventer, ca. 110 km from the North Sea coast. Due to the huge number of fish bones in the samples, only vertebrae were identified and counted (Laarman, 1989). Eel and cyprinids constitute the vast majority of the identified fish vertebrae, but marine species are available as well.

Groningen, Kattendiep (18)

During excavations at Gedempte Kattendiep-Kleine Peperstraat in Groningen a cesspit dating from the third quarter of the 16th century was found. Fish bones were recovered from soil samples by sieving through a 5 mm mesh. They were studied by Brinkhuizen (1988b).

Marine species, especially gadids and flatfishes, dominate the sample, but eel bones are also numerous. Haddock is the best represented gadid species. Some of the cod were big, about 100 cm.

Scheurrak SO1 (19)

Scheurrak SO1 is the wreck of a merchant vessel which sank in the late 16th century in the Dutch Wadden Sea, northeast of Oudeschild. Three barrels found in the wreck contained fish remains, two of the barrels were analyzed by Brinkhuizen (1994). Barrel 1 contained exclusively cod bones. The representation of bone elements shows that the fish were headless, and that a major part of the backbone had also been removed. Barrel 2 contained bones from cod, torsk and ling/blue ling. Here too, the fish were headless and lacked a large part of the backbone. Barrel 2 also contained the trunks of cod and torsk smaller than 55 cm, where the abdominal part of the backbone had been either totally removed, partly removed, or not removed at all. The length of the cod from the barrels was 35-115 cm, that of the torsk 50-60 cm, and that of the ling/blue ling 50-160 cm. The barrel contents have been interpreted as stockfish meant for consumption on board. Torsk and ling/blue ling are thought to have been caught in the northern part of the North Sea or further north still (Brinkhuizen, 1994).

Eindhoven (20)

Excavations in the former Eindhoven Castle, ca. 100 km from the North Sea coast, yielded fish bone material dating from the 16th to the first half of the 17th century AD. Most fish bones were recovered from a sieved sample. The fish bones were studied by de Jong (1994) who compared the fish bone evidence with written sources. In spite of the considerable distance to the sea, most remains are from marine species, with cod and flatfishes dominating, but there is a significant element of cyprinids and other freswhater species as well. Most of the cod were large (80-113 cm). The high number of remains of thornback ray is noteworthy.

THE NETHERLANDS, OVERVIEW

The oldest Dutch fish bone material covered here dates from the 1st century AD; the youngest reaches marginally into the 18th century. The fish bone samples derives from a varied selection of sources such as Roman military settlements, an early Medieval trading centre, several Medieval urban settlements, castles and a shipwreck. Several of the Dutch sites reviewed above were included in a review by Clason *et al.* (1982).

Local influences on Dutch fishing

The proximity of the North Sea is reflected by the presence of gadids at all sites except Nijmegen, Tiel, Schagen and Zweins, from most of which there is only a small amount of material which is perhaps not representative. Nijmegen and Tiel

furthermore lie relatively far from the sea. Cod, haddock, whiting and ling are present, and even torsk in the rather special material from a ship's cargo. Large cod, represented by both head and trunk bones, have been found in the material from Velsen, a 1st century AD site directly on the North Sea coast from where large cod could possibly have been caught. The proximity of the sea has resulted in a large number of marine species in the Velsen material; in addition to the gadids there are several species of sharks and rays, European seabass, Atlantic horse mackerel, meagre, striped red mullet, several species of grey mullet, mackerel, chub mackerel and tub gurnard. Several of these, smoothhound, common stingray, striped red mullet, chub mackerel and tub gurnard, have a southern distribution. Tub gurnard, for instance, is common off the Dutch North Sea coast but occurs only irregularly further north (Curry-Lindahl, 1985). The presence of these species on the Dutch sites, combined with their virtual absence in material from further north, is striking. Meagre, which has been found at two Dutch sites, viz. Ezinge (4th-3th centuries BC, Brinkhuizen, 1988a) and Velsen 1, is another southern species which is nowadays only rarely caught off the Dutch coast. Velsen 1 has provided the most varied Dutch material, probably due to its ideal location with opportunities for fishing in both salt as well as fresh waters. The fact that the fish bones have been recovered by sieving, resulting in a large representative assemblage, has, however, also played a role. This becomes clear if comparison is made with the otherwise comparable material from Velsen 2.

The material from Nijehove contains, i.a., European anchovy and smelt. The former is another southern species, which is rare north of The Netherlands. Both anchovy and smelt occur, the latter very abundantly, in the Wadden Sea, which is close to Nijehove.

The large amount of material from Dorestad, where sieving was employed, contains evidence of local fishing for a great number of freshwater and migratory fishes in the nearby rivers.

As another example of the local character of Dutch fishing, the small specimens of plaice/flounder/dab from Schagen can be mentioned: these could very well have been caught in the nearby Wadden sea. Also, the large amount of bones of twaite shad found at Valkenburg agrees with the present-day abundance of this species in the nearby coastal waters and inlets.

Although the Dutch fish bone assemblages represent different kinds of sites and different periods, no correlation between the type of fish bones and the kind of site or the period is evident. Differences between the Dutch sites relate rather to whether their location is coastal as opposed to well inland.

Brinkhuizen (1989a) noted that a number of marine species in the Velsen 1 material indicate that fishing took place in the summer half of the year. As all the marine species from Velsen 1 are demersal, Brinkhuizen suggested that fishing at sea was carried out exclusively with lines. On the other hand, the small cyprinids in the material suggest use of nets and traps in fresh water.

Remains of fishing tools from Dutch sites

A rectangular oaken frame, with a wickerwork bottom and remains of the sidewalls still present, was found in the harbour of Medieval Dorestad. This is probably the remains of a livebox which was suspended under water and used for keeping fish alive until needed (Prummel, 1978, 1982; Brinkhuizen, 1986). Brinkhuizen (1986) reviewed finds of prehistoric fishing tools from The Netherlands and other northwest European countries. The Dutch finds include gorges from Dorestad, Friesland and Groningen. Remains of wickerwork fishtraps have been found in the harbour complex at Dorestad (Prummel, 1983; Brinkhuizen, 1986).

Indications of fish trade in the Netherlands

The trading centre of Dorestad was situated far inland but was accessible via rivers. Bones of several marine species have been found here, viz., herring, haddock, unspecified gadids and flatfish. These are the very fish which are suitable for drying or salting with a view to long-distance transport. Remains of gadids and flatfishes have also been found at other inland sites: Utrecht, Deventer and Eindhoven. In these cases fish imported from the North Sea coast must be involved. Groenman-van Waateringe & van Wijngaarden-Bakker (1990) noted that particularly at inland sites, trade in marine fish may be traced, mainly from the 14th century AD onwards, and that at some coastal sites in the southern Netherlands, freshwater fish are frequently found in 14th century AD deposits, whereas they are almost entirely absent from contemporaneous sites in the northern part of the country.

The cod bones from Leeuwarden have been interpreted as remains of stockfish (Brinkhuizen, 1983). The bones in question are five parasphenoid bones from ca. 1 m long cod. Several of the parasphenoids have been split longitudinally or carry longitudinal cutmarks, indicating that the fish were split for the purpose of being dried. The finds of ling in the same assemblages are also interpreted as remains of imported stockfish. Straightforward proof that gadids were actually transported is provided by the shipwreck Scheurrak SO1 in which remains of stockfish in barrels were found. This find shows that cod, ling and torsk were all used for this purpose, and the 16th century butchering technique for gadids can be deduced. Brinkhuizen (1994) speculated that torsk and ling/blue ling came from the northern North Sea or from even further north - torsk has never been caught in Dutch waters.

There is a further example of cured fish which deserves mention, although it is from a somewhat younger period, i.e., the 17th century. This is a find of fish remains from a Dutch whaling station on the island of Spitzbergen in the Arctic Sea. This find includes 3488 cod bones, which are interpreted as remains of preserved fish because the head bones are absent. The Spitzbergen material also includes 386 bones of herring, which were probably caught in the North Sea. It is characteristic that bones from the area behind the herring's head are missing. This is a result of a cut being made behind the head as part of the preservation process (Seeman, 1986). The find on Spitzbergen thus represents the product (known as "haring kaken" in Dutch) of this processing method, in which the gills are removed. In contrast, an example of the corresponding processing refuse was found at the Danish site of Selsø-Vestby, 13th century AD (Enghoff, 1996).

Bones of chub mackerel have been found only at two sites in the Netherlands, both Roman: Velsen 1 and Nijmegen. Brinkhuizen (1989b) and Lauwerier (1993) suggested that these finds indicate import of products to these sites from remote coasts. The find of barracuda at Nijmegen (Lauwerier, 1988) is another example of import of exotic species.

BELGIUM, INDIVIDUAL SITES

The review is based on previous publications, in particular on the review article by Van Neer & Ervynck (1994b) from which much of the following has been directly taken. When no particular reference is given, the archaeological information is from Van Neer & Ervynck's paper.

The site numbers refer to the map, Figure 6. See Table 5 for detailed species lists.

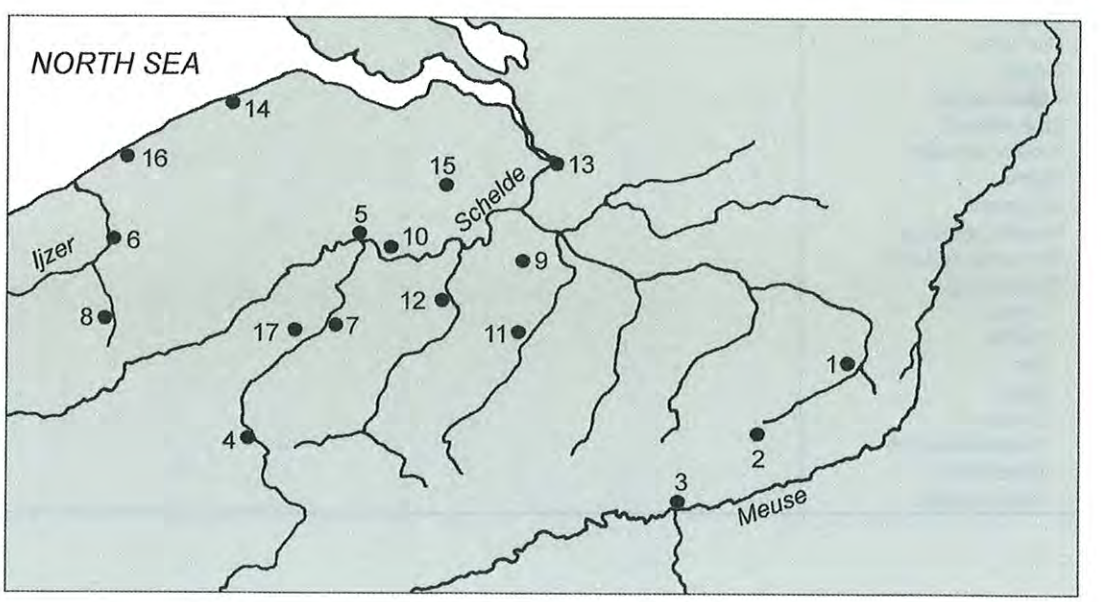

FIGURE 6

Map of Belgium, showing the location of the reviewed sites. Site numbers refer to the section "Belgium, individual sites". Modified after Van Neer & Ervynck (1994b).

Site	Tongeren, Hond-straat	Tongeren, Veemarkt	Tongeren, Minder-broeder-straat	Braives	Namur, Place Marché aux Légumes	Namur, Saint-Gilles	Namur, Saint-Gilles
Site no. (Fig. 6)	1	1	1	2	3	3	3
Age (centuries)	1-2 AD	2 AD	2-4 AD	3 AD	2-3 AD	3-5 AD	11-13 AD
Recovery technique	h	s	s	s	s	h	h
MARINE SPECIES							
Nursehound	-	-	-	-	-	-	-
Topeshark	-	-	-	-	-	-	-
Thornback ray	-	-	-	-	-	-	-
Ray, unspecified	-	-	-	-	-	-	-
Cartilaginous fishes, unspecified	-	-	-	-	-	-	-
Herring	-	-	-	-	-	-	-
Sprat	-	-	-	2	-	-	-
Herring/Sprat	-	-	-	56	-	-	-
European anchovy	-	-	-	-	-	-	-
Garfish	-	-	-	-	-	-	-
Gadids, total	-	-	-	3	-	-	-
Cod	-	-	-	-	-	-	-
Haddock	-	-	-	-	-	-	-
Whiting	-	-	-	3	-	-	-
Saithe	-	-	-	-	-	-	-
Ling	-	-	-	-	-	-	-
Gadids, unspecified	-	-	-	-	-	-	-
European sea bass	-	-	-	-	-	-	-
Black sea bream	-	-	-	-	-	-	-
Meagre	-	-	-	-	-	-	-
Grey mullets	-	-	-	-	-	-	-
Sandeel	-	-	-	1	-	-	-
Atlantic mackerel	-	-	-	-	-	-	-
Chub mackerel	-	-	1	-	-	-	-
Gobiids, unspecified	-	-	-	-	-	-	-
Bullrout	-	-	-	-	-	-	-
Tub gurnard	-	-	-	-	-	-	-
Gurnards, unspecified	-	-	-	-	-	-	-
Three-spined stickleback	-	-	-	1	-	-	-
Flatfishes, total	-	-	-	-	-	-	-
Turbot	-	-	-	-	-	-	-
Halibut	-	-	-	-	-	-	-
Dab	-	-	-	-	-	-	-
Plaice	-	-	-	-	-	-	-
Flounder	-	-	-	-	-	-	-
Plaice/Flounder/Dab	-	-	-	-	-	-	-
Common sole	-	-	-	-	-	-	-
Sole, unspecified	-	-	-	-	-	-	-

TABLE 5

Numbers of identified fish bones from Belgian sites. Recovery technique: h = hand-collected, s = sieved, ? = unknown.

Site	Tongeren, Hond-straat	Tongeren, Veemarkt	Tongeren, Minder-broeder-straat	Braives	Namur, Place Marché aux Légumes	Namur, Saint-Gilles	Namur, Saint-Gilles
Site no.	1	1	1	2	3	3	3
Age (centuries)	1-2 AD	2 AD	2-4 AD	3 AD	2-3 AD	3-5 AD	11-13 AD
Recovery technique	h	s	s	s	s	h	h
MIGRATORY SPECIES							
Sturgeon	-	-	-	-	-	-	1
Shad	-	-	-	-	-	-	-
Trout	-	6	-	-	-	-	-
Whitefish	-	-	1	-	-	-	-
Salmonids, unspecified	6	-	-	-	-	5	-
Smelt	-	-	-	1	-	-	-
Eel	-	12	-	-	+	-	-
FRESHWATER SPECIES							
Pike	-	3	-	-	-	-	-
Cyprinids, total	21	88	4	-	+	19	-
Common carp	-	-	-	-	-	-	-
Gudgeon	-	-	-	-	+	-	-
Barbel	1	-	-	-	-	2	-
Bleak	-	-	-	-	-	-	-
Schneider	-	-	-	-	-	-	-
Tench	-	-	-	-	-	-	-
Minnow	-	10	-	-	-	-	-
Dace	-	9	-	-	-	-	-
Chub	1	4	-	-	-	-	-
Orfe	-	-	-	-	-	3	-
Dace/Chub/Orfe	-	-	-	-	-	1	-
Roach	-	-	-	-	+	-	-
Rudd	-	-	-	-	-	-	-
Common Bream	-	-	-	-	-	-	-
White Bream	-	-	-	-	-	-	-
Spined loach	-	-	-	-	-	-	-
Stone loach	-	-	-	-	-	-	-
Cyprinids, unspecified	19	65	4	-	+	13	-
Wels	-	-	-	-	-	3	-
Burbot	-	-	-	-	-	-	-
Perch	10	4	+[1]	-	-	-	-
Ruffe	-	-	-	-	-	-	-
Percids, unspecified	-	-	-	-	-	-	-
Bullhead	-	1?	-	-	-	-	-
TOTAL	37	116	6	64	+	27	1

TABLE 5 (cont.)

Numbers of identified fish bones from Belgian sites. Recovery technique: h = hand-collected, s = sieved, ? = unknown.

[1] 6 scales.

Site	Namur, Grognon	Namur, Grognon	Namur, Saint-Gilles	Tournai	Gent, Veemarkt	Gent, Kammer-straat	Gent, Belfort-straat
Site no. (Fig. 6)	3	3	3	4	5	5	5
Age (centuries)	12 AD	15-16 AD	14-15 AD	4-5 AD	7-8 AD	12 AD	13 AD
Recovery technique	s	s	s	h	h	h	h+s
MARINE SPECIES							
Nursehound	-	-	-	-	-	-	-
Topeshark	-	-	-	-	-	-	-
Thornback ray	-	-	-	-	-	-	-
Ray, unspecified	-	-	-	-	-	-	1
Cartilaginous fishes, unspecified	-	-	-	-	-	-	-
Herring	5	148	21	-	-	-	71
Sprat	-	-	-	-	-	-	-
Herring/Sprat	-	-	-	-	-	-	-
European anchovy	-	-	-	-	-	-	-
Garfish	-	-	-	-	-	-	-
Gadids, total	-	1	2	-	-	9	82
Cod	-	1	1	-	-	5	7
Haddock	-	-	1	-	-	2	41
Whiting	-	-	-	-	-	-	14
Saithe	-	-	-	-	-	-	-
Ling	-	-	-	-	-	-	-
Gadids, unspecified	-	-	-	-	-	2	20
European sea bass	-	-	-	-	-	-	-
Black sea bream	-	-	-	-	-	-	-
Meagre	-	-	-	-	-	-	-
Grey mullets	-	-	-	-	-	-	-
Sandeel	-	-	-	-	-	-	-
Atlantic mackerel	-	-	-	-	-	-	-
Chub mackerel	-	-	-	-	-	-	-
Gobiids, unspecified	-	-	-	-	-	-	-
Bullrout	-	-	-	-	-	-	-
Tub gurnard	-	-	-	-	-	-	-
Gurnards, unspecified	-	-	-	-	-	-	-
Three-spined stickleback	19	-	6	-	-	-	-
Flatfishes, total	-	-	-	-	-	3	98
Turbot	-	-	-	-	-	-	-
Halibut	-	-	-	-	-	-	-
Dab	-	-	-	-	-	-	-
Plaice	-	-	-	-	-	-	-
Flounder	-	-	-	-	-	-	-
Plaice/Flounder/Dab	-	-	-	-	-	3	98
Common sole	-	-	-	-	-	-	-
Sole, unspecified	-	-	-	-	-	-	-

TABLE 5 (cont.)

Numbers of identified fish bones from Belgian sites. Recovery technique: h = hand-collected, s = sieved, ? = unknown.

Site	Namur, Grognon	Namur, Grognon	Namur, Saint-Gilles	Tournai	Gent, Veemarkt	Gent, Kammer-straat	Gent, Belfort-straat
Site no.	3	3	3	4	5	5	5
Age (centuries)	12 AD	15-16 AD	14-15 AD	4-5 AD	7-8 AD	12 AD	13 AD
Recovery technique	s	s	s	h	h	h	h+s
MIGRATORY SPECIES							
Sturgeon	-	-	-	-	1	-	4
Shad	-	-	-	-	1	-	-
Trout	-	-	-	-	-	-	-
Whitefish	-	-	-	-	-	-	-
Salmonids, unspecified	-	-	-	-	-	-	-
Smelt	-	-	-	-	-	-	3
Eel	14	20	6	-	-	-	42
FRESHWATER SPECIES							
Pike	4	1	-	3	-	-	6
Cyprinids, total	148	323	69	4	2	-	11
Common carp	-	2	-	-	-	-	-
Gudgeon	5	5	-	-	-	-	-
Barbel	3	8	3	-	-	-	-
Bleak	2	1	-	-	-	-	-
Schneider	29	4	-	-	-	-	-
Tench	-	-	-	-	-	-	-
Minnow	-	-	-	-	-	-	-
Dace	5	8	-	-	-	-	-
Chub	-	3	3	-	-	-	-
Orfe	3	-	-	-	-	-	-
Dace/Chub/Orfe	1	1	-	1	-	-	-
Roach	7	10	-	-	-	-	-
Rudd	-	-	-	-	-	-	-
Common Bream	-	-	-	-	2	-	-
White Bream	-	-	-	-	-	-	-
Spined loach	13	-	3	-	-	-	-
Stone loach	-	-	8	-	-	-	-
Cyprinids, unspecified	80[2]	281	52	3	-	-	11
Wels	-	1	-	-	-	-	-
Burbot	-	-	-	-	-	-	-
Perch	2	2	-	-	-	-	5
Ruffe	-	-	-	-	-	-	-
Percids, unspecified	-	1[3]	-	-	-	-	-
Bullhead	8	-	20	-	-	-	-
TOTAL	200	493	124	7	4	12	323

TABLE 5 (cont.)

Numbers of identified fish bones from Belgian sites. Recovery technique: h = hand-collected, s = sieved, ? = unknown.

[2] excluding 31 scales.

[3] excluding 3 scales.

Site	Diksmuide	Ename	Ename	Ename	Ieper	Londer-zeel	Laarne
Site no. (Fig. 6)	6	7	7	7	8	9	10
Age (centuries)	12-13 AD	12-13 AD	14-15 AD	15-16 AD	13 AD	13-14 AD	13-14 AD
Recovery technique	s	h+s	s	s	s	h+s	s
MARINE SPECIES							
Nursehound	-	-	-	-	-	-	-
Topeshark	-	-	-	-	-	-	-
Thornback ray	+	-	1	13	-	-	-
Ray, unspecified	-	-	-	-	-	-	-
Cartilaginous fishes, unspecified	-	-	-	-	-	-	-
Herring	+	4	59	234	-	272	+
Sprat	-	-	-	-	-	-	-
Herring/Sprat	-	-	-	-	-	-	-
European anchovy	-	-	-	-	-	-	-
Garfish	-	-	-	-	-	-	-
Gadids, total	+	4	11	91	16	249	+
Cod	+	2	-	8	5	4	-
Haddock	+	-	4	14	3	75	+
Whiting	+	-	-	10	-	116	-
Saithe	-	-	-	-	-	-	-
Ling	-	-	-	-	-	-	-
Gadids, unspecified	-	2	7	59	8	54	+
European sea bass	-	-	-	-	1	-	-
Black sea bream	-	-	-	-	2	-	-
Meagre	-	-	-	-	-	-	-
Grey mullets	-	-	-	-	-	11	-
Sandeel	-	-	-	-	-	-	-
Atlantic mackerel	+	-	-	-	-	-	+
Chub mackerel	-	-	-	-	-	-	-
Gobiids, unspecified	-	-	-	-	-	-	-
Bullrout	-	-	-	-	-	-	-
Tub gurnard	+	-	-	-	4	-	-
Gurnards, unspecified	-	-	2	-	-	-	-
Three-spined stickleback	-	-	-	-	-	-	-
Flatfishes, total	+	-	24	176	1	93	+
Turbot	-	-	-	1	-	-	-
Halibut	-	-	-	-	-	-	-
Dab	-	-	-	-	-	-	-
Plaice	-	-	-	8	-	-	-
Flounder	-	-	-	1	-	-	-
Plaice/Flounder/Dab	+	-	9	149	1	93	+
Common sole	-	-	-	17	-	-	-
Sole, unspecified	-	-	15	-	-	-	-

TABLE 5 (cont.)

Numbers of identified fish bones from Belgian sites. Recovery technique: h = hand-collected, s = sieved, ? = unknown.

Site	Diksmuide	Ename	Ename	Ename	Ieper	Londer-zeel	Laarne
Site no.	6	7	7	7	8	9	10
Age (centuries)	12-13 AD	12-13 AD	14-15 AD	15-16 AD	13 AD	13-14 AD	13-14 AD
Recovery technique	s	h+s	s	s	s	h+s	s
MIGRATORY SPECIES							
Sturgeon	-	-	-	1	-	39	-
Shad	-	-	-	-	-	-	-
Trout	-	-	-	-	-	-	-
Whitefish	-	-	-	1	-	22	-
Salmonids, unspecified	-	-	-	2	-	-	-
Smelt	-	-	-	-	-	-	-
Eel	+	5	39	175	-	90	+
FRESHWATER SPECIES							
Pike	-	-	4	20	-	42	+
Cyprinids, total	-	7	67	659	-	218	+
Common carp	-	-	35	116	-	1	2
Gudgeon	-	-	-	-	-	-	-
Barbel	-	-	-	-	-	-	-
Bleak	-	-	-	-	-	-	-
Schneider	-	-	-	-	-	-	-
Tench	-	-	-	-	-	4	-
Minnow	-	-	-	-	-	-	-
Dace	-	-	-	-	-	-	-
Chub	-	-	-	-	-	-	-
Orfe	-	-	-	-	-	1	-
Dace/Chub/Orfe	-	-	-	-	-	-	-
Roach	-	-	2	11	-	9	-
Rudd	-	-	1	2	-	2	-
Common Bream	-	-	1	-	-	-	-
White Bream	-	-	1	-	-	1	-
Spined loach	-	-	-	-	-	-	-
Stone loach	-	-	-	-	-	-	-
Cyprinids, unspecified	-	7	27	530	-	200	+
Wels	-	-	-	-	-	-	-
Burbot	-	-	1	2	-	-	-
Perch	-	3[4]	2	9	-	57	-
Ruffe	-	-	-	5	-	-	+
Percids, unspecified	-	-	-	-	-	-	-
Bullhead	-	-	-	-	-	-	-
TOTAL	+	23	210	1388	24	1093	+

TABLE 5 (cont.)

Numbers of identified fish bones from Belgian sites. Recovery technique: h = hand-collected, s = sieved, ? = unknown.

[4] excluding 12 scales.

Site	Brussels, St. Clara	Brussels, St. Clara	Brussels, Sarma	Brussels, Sarma	Aalst	Antwerpen, Burchtgracht	Antwerpen, St. Ontcommer
Site no. (Fig. 6)	11	11	11	11	12	13	13
Age (centuries)	13-14 AD	15-16 AD	14-15 AD	16-17 AD	14 AD	14 AD	16 AD
Recovery technique	h	h	h	h	s	h+s	h
MARINE SPECIES							
Nursehound	-	-	-	-	-	-	-
Topeshark	-	-	-	-	-	-	-
Thornback ray	-	1	-	-	-	-	-
Ray, unspecified	-	-	-	-	-	-	-
Cartilaginous fishes, unspecified	-	-	-	-	-	-	-
Herring	-	-	-	-	77	41	-
Sprat	-	-	-	-	-	-	-
Herring/Sprat	-	-	-	-	-	-	-
European anchovy	-	-	-	-	-	-	-
Garfish	-	-	-	-	-	-	-
Gadids, total	9	128	23	16	16	38	12
Cod	7	59	7	7	-	9	10
Haddock	2	34	8	1	9	15	2
Whiting	-	-	-	-	-	5	-
Saithe	-	-	-	-	-	-	-
Ling	-	-	-	-	-	-	-
Gadids, unspecified	-	35	8	8	7	9	-
European sea bass	-	-	-	-	-	-	-
Black sea bream	-	-	-	-	-	-	-
Meagre	-	1	-	-	-	-	-
Grey mullets	-	-	-	-	-	-	1
Sandeel	-	-	-	-	-	-	-
Atlantic mackerel	-	-	-	-	-	-	-
Chub mackerel	-	-	-	-	-	-	-
Gobiids, unspecified	-	-	-	-	-	-	-
Bullrout	-	-	-	-	-	-	-
Tub gurnard	-	1	-	-	-	-	-
Gurnards, unspecified	-	-	-	-	-	-	-
Three-spined stickleback	-	-	-	-	-	-	-
Flatfishes, total	3	22	6	3	130	60	1
Turbot	-	-	-	-	-	-	-
Halibut	-	-	-	-	-	-	-
Dab	-	-	-	-	-	-	-
Plaice	-	-	-	-	3	-	-
Flounder	-	-	-	-	1	-	-
Plaice/Flounder/Dab	3	22	6	3	126	60	1
Common sole	-	-	-	-	-	-	-
Sole, unspecified	-	-	-	-	-	-	-

TABLE 5 (cont.)

Numbers of identified fish bones from Belgian sites. Recovery technique: h = hand-collected, s = sieved, ? = unknown.

Site	Brussels, St. Clara	Brussels, St. Clara	Brussels, Sarma	Brussels, Sarma	Aalst	Ant-werpen, Burcht-gracht	Ant-werpen, St. Ont-commer
Site no.	11	11	11	11	12	13	13
Age (centuries)	13-14 AD	15-16 AD	14-15 AD	16-17 AD	14 AD	14 AD	16 AD
Recovery technique	h	h	h	h	s	h+s	h
MIGRATORY SPECIES							
Sturgeon	-	-	-	1	-	-	1
Shad	-	-	-	-	-	1	-
Trout	-	-	-	-	-	-	-
Whitefish	-	-	-	-	-	-	-
Salmonids, unspecified	-	-	-	-	-	-	-
Smelt	-	-	-	-	-	-	-
Eel	-	-	-	-	47	30	-
FRESHWATER SPECIES							
Pike	-	1	-	-	-	1	-
Cyprinids, total	-	6	3	6	97	10	-
Common carp	-	1	1	1	1		-
Gudgeon	-	-	-	-	-	-	-
Barbel	-	-	-	-	-	-	-
Bleak	-	-	-	-	-	-	-
Schneider	-	-	-	-	-	-	-
Tench	-	-	-	1	-	-	-
Minnow	-	-	-	-	-	-	-
Dace	-	-	-	-	-	-	-
Chub	-	-	-	-	-	-	-
Orfe	-	-	-	-	-	-	-
Dace/Chub/Orfe	-	-	-	-	-	-	-
Roach	-	-	-	-	5	-	-
Rudd	-	-	-	-	1	-	-
Common Bream	-	-	-	-	-	-	-
White Bream	-	-	-	-	-	-	-
Spined loach	-	-	-	-	-	-	-
Stone loach	-	-	-	-	-	-	-
Cyprinids, unspecified	-	5	2	4	90[5]	10	-
Wels	-	-	-	-	-	-	-
Burbot	-	-	-	-	-	-	-
Perch	-	-	-	-	19[6]	2	-
Ruffe	-	-	-	-	-	-	-
Percids, unspecified	-	-	-	-	-	-	-
Bullhead	-	-	-	-	-	-	-
TOTAL	12	160	32	26	386	183	15

TABLE 5 (cont.)

Numbers of identified fish bones from Belgian sites. Recovery technique: h = hand-collected, s = sieved, ? = unknown.

[5] excluding 549 scales.

[6] excluding 51 scales.

Site	Antwerpen, Episcopal Palace	Antwerpen, Gulden-berg	Antwerpen, Zwart-zuster-straat	Heist	Sinaai	Raversijde I	Raversijde II "pit"
Site no. (Fig. 6)	13	13	13	14	15	16	16
Age (centuries)	16-17 AD	16-17 AD	16-17 AD	14-16 AD	14-16 AD	15 AD	15 AD
Recovery technique	s	s	h+s	s	h	s	h
MARINE SPECIES							
Nursehound	-	-	-	-	-	1	-
Topeshark	-	-	-	-	-	1	-
Thornback ray	-	-	-	1	-	+	-
Ray, unspecified	-	-	-	-	-	-	-
Cartilaginous fishes, unspecified	-	-	-	-	-	-	-
Herring	+	3	2	268	-	+	5
Sprat	-	-	-	-	-	-	-
Herring/Sprat	-	-	-	-	-	-	-
European anchovy	-	-	2	-	-	-	-
Garfish	-	-	1	-	-	-	-
Gadids, total	+	37	32	616	82	+	32
Cod	+	14	20	1	34	+	12
Haddock	+	13	4	43	17	+	4
Whiting	+	-	-	220	-	+	-
Saithe	-	-	-	10	-	-	-
Ling	+	-	-	56	-	-	-
Gadids, unspecified	+	10	8	286	31	-	16
European sea bass	-	-	-	-	-	-	-
Black sea bream	-	-	-	-	-	-	-
Meagre	-	-	-	-	-	-	-
Grey mullets	-	-	-	-	-	-	-
Sandeel	-	-	-	-	-	-	-
Atlantic mackerel	-	-	-	-	-	-	-
Chub mackerel	-	-	-	-	-	-	-
Gobiids, unspecified	-	-	-	-	-	-	-
Bullrout	-	-	-	4	-	-	-
Tub gurnard	-	-	-	1	-	-	-
Gurnards, unspecified	-	-	-	-	-	-	-
Three-spined stickleback	-	-	-	-	-	-	-
Flatfishes, total	+	43	24	169	26	+	111
Turbot	-	-	-	-	-	-	-
Halibut	-	-	-	-	-	-	-
Dab	-	-	-	1	-	-	-
Plaice	-	-	2	5	-	-	-
Flounder	-	-	-	-	-	-	1
Plaice/Flounder/Dab	+	43	21	163	26	+	110
Common sole	-	-	1	-	-	-	-
Sole, unspecified	-	-	-	-	-	-	-

TABLE 5 (cont.)

Numbers of identified fish bones from Belgian sites. Recovery technique: h = hand-collected, s = sieved, ? = unknown.

Site	Antwerpen, Episcopal Palace	Antwerpen, Guldenberg	Antwerpen, Zwartzusterstraat	Heist	Sinaai	Raversijde I	Raversijde II "pit"
Site no.	13	13	13	14	15	16	16
Age (centuries)	16-17 AD	16-17 AD	16-17 AD	14-16 AD	14-16 AD	15 AD	15 AD
Recovery technique	s	s	h+s	s	h	s	h
MIGRATORY SPECIES							
Sturgeon	-	-	2	-	1	-	-
Shad	+	-	-	-	-	-	-
Trout	-	-	-	-	-	-	-
Whitefish	-	-	-	-	-	-	-
Salmonids, unspecified	+	-	2	-	-	-	-
Smelt	+	-	-	-	-	-	-
Eel	+	2	-	6	-	+	6
FRESHWATER SPECIES							
Pike	+	-	1	-	3	-	-
Cyprinids, total	+	1	8	1	1	+	1
Common carp	+	-	4	-	-	-	1
Gudgeon	-	-	-	-	-	-	-
Barbel	-	-	-	-	-	-	-
Bleak	-	-	-	-	-	-	-
Schneider	-	-	-	-	-	-	-
Tench	-	-	-	-	-	-	-
Minnow	-	-	-	-	-	-	-
Dace	-	-	-	-	-	-	-
Chub	-	-	-	-	-	-	-
Orfe	-	-	-	-	-	-	-
Dace/Chub/Orfe	-	-	-	-	-	-	-
Roach	+	-	-	1	-	-	-
Rudd	+	-	-	-	-	-	-
Common Bream	-	-	-	-	-	-	-
White Bream	-	-	-	-	-	-	-
Spined loach	-	-	-	-	-	-	-
Stone loach	-	-	-	-	-	-	-
Cyprinids, unspecified	+	1	4	-	1	+	-
Wels	-	-	-	-	-	-	-
Burbot	-	-	-	-	-	-	-
Perch	-	-	-	-	1	-	-
Ruffe	-	-	-	-	-	-	-
Percids, unspecified	-	-	-	-	-	-	-
Bullhead	-	-	-	-	-	-	-
TOTAL	+	86	74	1066	114	+	155

TABLE 5 (cont.)

Numbers of identified fish bones from Belgian sites. Recovery technique: h = hand-collected, s = sieved, ? = unknown.

Site	Raversijde II "lens"	Petegem
Site no. (Fig. 6)	16	17
Age (centuries)	15 AD	16 AD
Recovery technique	s	h+s
MARINE SPECIES		
Nursehound	-	-
Topeshark	-	-
Thornback ray	1	6
Ray, unspecified	1	-
Cartilaginous fishes, unspecified	-	-
Herring	44	-
Sprat	-	-
Herring/Sprat	-	-
European anchovy	-	-
Garfish	-	-
Gadids, total	5	147
Cod	-	50
Haddock	1	4
Whiting	3	-
Saithe	-	-
Ling	-	-
Gadids, unspecified	1	93
European sea bass	-	-
Black sea bream	-	-
Meagre	-	-
Grey mullets	-	-
Sandeel	-	-
Atlantic mackerel	-	-
Chub mackerel	-	-
Gobiids, unspecified	4	-
Bullrout	-	-
Tub gurnard	-	-
Gurnards, unspecified	-	-
Three-spined stickleback	-	-
Flatfishes, total	9807	36
Turbot	-	-
Halibut	-	-
Dab	-	-
Plaice	183	-
Flounder	-	-
Plaice/Flounder/Dab	9624	35
Common sole	-	1
Sole, unspecified	-	-

TABLE 5 (cont.)

Numbers of identified fish bones from Belgian sites. Recovery technique: h = hand-collected, s = sieved, ? = unknown.

Site	Raversijde II "lens"	Petegem
Site no.	16	17
Age (centuries)	15 AD	16 AD
Recovery technique	s	h+s
MIGRATORY SPECIES		
Sturgeon	-	-
Shad	-	-
Trout	-	-
Whitefish	-	-
Salmonids, unspecified	-	-
Smelt	-	-
Eel	9	-
FRESHWATER SPECIES		
Pike	-	-
Cyprinids, total	-	23
Common carp	-	-
Gudgeon	-	-
Barbel	-	-
Bleak	-	-
Schneider	-	-
Tench	-	1
Minnow	-	-
Dace	-	-
Chub	-	-
Orfe	-	-
Dace/Chub/Orfe	-	-
Roach	-	-
Rudd	-	-
Common Bream	-	-
White Bream	-	-
Spined loach	-	-
Stone loach	-	-
Cyprinids, unspecified	-	22
Wels	-	-
Burbot	-	-
Perch	-	-
Ruffe	-	-
Percids, unspecified	-	-
Bullhead	-	-
TOTAL	9871	212

TABLE 5 (cont.)

Numbers of identified fish bones from Belgian sites. Recovery technique: h = hand-collected, s = sieved, ? = unknown.

Tongeren: Hondstraat and Veemarkt (1)

A former Roman inland *civitas* capital. During rescue excavations, fish bones were hand-collected from a cesspit found at Hondstraat in the backyard of a rich Roman urban residence dated to the 1st-2nd centuries AD. From another cesspit (at Veemarkt), which once belonged to a rich household from the 2nd century AD, fish bones were recovered by sieving.

The fish represented in these cesspits are exclusively freshwater and migratory species.

Tongeren, Minderbroederstraat (1)

Vanderhoeven *et al.* (1994) reported on fish bones from a third pit in Tongeren. They were recovered by sieving and dated to the 2nd century AD.

In addition to freshwater fish (cyprinids and perch) this sample contains a bone of the marine chub mackerel. This species is very rare off the Belgian coast today and the find is interpreted as the remains of imported salted fish or fish sauce from the South, the first Belgian find of its kind. At the same site, a small number of fish remains were found in the fill of a fourth century oven. These include a vertebra of the whitefish family which does not occur in Belgian inland waters today.

Braives (2)

A late Roman inland settlement. Fish remains were recovered by sieving through a 0.5 mm mesh from the 3rd century AD fill of a well.

In spite of the inland location of Braives, the material is dominated by marine species, mostly herring/sprat. Whiting, smelt, sandeel and three-spined stickleback are also present. The specimens were all very small (4-5 cm). Van Neer & Lentacker (1994) reached the conclusion that the fish must have been caught in inshore waters along the northeastern Atlantic coast, during spring or early summer, using small-meshed fishing gear. Due to the poor durability of such small fish, Van Neer & Lentacker (1994) assumed that they were preserved in the form of fish sauce before being transported to Braives.

Namur, Place Marché aux Légumes and Saint-Gilles (3)

Namur is an inland site, ca. 125 from the coast, from where several fish bone assemblages have been studied. Excavations of the central part of a Roman settlement at the Place Marché aux Légumes yielded fish bone material. This was recovered by sieving the fill of a well from the 2nd-3rd centuries AD. Excavation at Saint-Gilles yielded faunal remains corresponding to a peripheral part of the settlement near the ancient harbour. There is material from three periods at the Saint-Gilles site: hand-collected material from the 3rd-5th and the 11th-13th centuries AD, and a sieved sample from a pot found in the well and dated to the 14th-15th centuries AD.

The fish found at the Place Marché aux Légumes are migratory and freshwater species, especially cyprinids. The same is true of the two oldest samples from Saint-Gilles. In contrast, the late Medieval material (14th-15th centuries) also contains marine species: herring, cod and haddock.

Namur, Grognon (3)

Fish remains were recovered from this site at Namur by sieving the contents of a cesspit excavated in 1995 through 5 mm, 4 mm and 2 mm meshes. The fish bones are dated partly to the 12th, and partly to the 15th-16th centuries AD. They were studied by Van Neer & Lentacker (1996).

Naturally enough, most of the fish bones are from freshwater species but two marine species are present, viz., herring and cod. Among the freshwater fish, the presence of wels and common carp in the 15th-16th century material should be noted. The latter indicates pisciculture (carp production). All the specimens of freshwater fish are very small, for example pike (10-25 cm) and eel (20-30 cm). This suggests intense exploitation of the fish fauna.

Tournai (4)

A fortress in the central part of a Roman settlement on the River Scheldt. Faunal remains were hand-collected and dated to the 4th-5th centuries AD.

The few fish bones from Tournai are from freshwater species: cyprinids and pike.

Gent, Veemarkt, Kammerstraat and Belfortstraat (5)

Gent is situated more than 40 km from the coast, on the River Schelde. The few fish bones

from Veemarkt are from the 7th-8th centuries AD and were hand-collected from a Merovingian well. The small amount of hand-collected material from Kammerstraat represents 12th century AD household refuse. A somewhat larger body of material was partly hand-collected, partly sieved from slightly younger deposits (an urban refuse heap from the 13th century AD) at Belfortstraat.

The Veemarkt and Kammerstraat fish bone samples are too small to be considered representative. The Belfortstraat assemblage is dominated by marine fish: ray, herring, cod, whiting, haddock and plaice/flounder/dab. In addition there are bones of freshwater and migratory species, for example, sturgeon, smelt and eel. The 12th century (Kammerstraat) sample also contains marine fish, whereas that from the 7th-8th centuries (Veemarkt) does not.

Diksmuide (6)

A site lying about 20 km from the coast, on the River Ijzer. The material was recovered by sieving of a refuse layer dated to the 12th-13th centuries.

The material has only been preliminarily analyzed but seems to be dominated by marine species, in particular herring, cod, haddock and plaice/flounder/dab. Other notable species are ray, whiting, tub gurnard and Atlantic mackerel.

Ename, Abbey of St. Salvator (7)

An inland abbey in East Flanders, ca 60 km from the sea.

One assemblage, dated to the 12th-13th centuries AD, is from a cesspit at the abbot's lodgings. It represents a mixture of household refuse and human excrement. The fish bones, which were recovered by hand-collecting and sieving, represent freshwater as well as marine species (Ervynck *et al.*, 1994).

Further material from this site derives from a cess- and refuse pit (14-15th centuries AD) from the guest quarters of the abbey. The fish bones are from a sample of 25 litres sieved through a 0.5 mm mesh. Marine and freshwater species are roughly equally represented. Herring, eel and common carp are the most frequent species (Ervynck *et al.*, 1996).

A third source of material from the Ename abbey is constituted by food debris which had gradually accumulated under a kitchen floor in the abbey. This material is from the 15th-16th centuries AD and was sieved. The fish bones represent no less than 20 different species (Van Neer & Ervynck, 1994b; Ervynck & Van Neer, 1992a).

Even though Ename lies far from the sea, there are bones from several marine fish species, i.e., thornback ray, herring, haddock, cod, whiting, common sole, plaice, flounder and turbot. The herring from the 15-16th centuries kitchen debris appear to have had their gills removed, bones from the shoulder girdle being consistently absent. The most frequent freshwater species is the common carp.

Van Neer & Ervynck (1996) reviewed all the fish bone assemblages from Ename.

Ieper, Lakenhalle (8)

A site ca. 35 km from the coast, lying on a tributary of the River Ijzer. A small number of fish bones were hand-collected from a 13th century refuse layer, excavated in the inner court of the Cloth Hall of Ieper. All bones are from marine species: cod, haddock and plaice/flounder/dab, plus an element of southern species: tub gurnard, European seabass and black sea bream (Ervynck *et al.*, 1990).

Londerzeel (9)

A castle situated about 80 km from the sea. A late Medieval refuse layer was excavated from the slope of the castle moat. The material, which was recovered using both hand-sampling and sieving, is presumed to reflect the general food consumption of the castle household.

The large and varied assemblage includes marine, migratory and freshwater species. Bones from herring, cod, whiting, haddock and plaice/flounder/dab are very frequent, as are bones from eel and cyprinids, the latter being represented by no less than six species.

Laarne (10)

Another castle, more than 60 km from the sea. A refuse deposit, dated to the 13th-14th centuries AD, was found in a cellar. The refuse probably comes from the servants' quarters and does not illustrate the consumption habits of the castle owners. The entire material was sieved.

The material includes both marine and freshwater species. Most frequent are herring, haddock and plaice/flounder/dab.

Brussels: St. Clara and Sarma (11)

Brussels is situated just less than 100 km from the sea, on a tributary to the River Schelde. Several urban refuse deposits were found at St. Clara Abbey in central Brussels and were dated to the 13th-14th centuries AD, i.e. prior to the abbey being built. A few fish bones were hand-collected. Somewhat younger (15th-16th centuries) hand-collected material from the same place represents household refuse, most probably brought in from the urban neighbourhood.

Several hand-collected late Medieval assemblages representing refuse were collected at the site Sarma. They are dated to either the 14th-15th or the 16th-17th centuries AD.

In the finds from Brussels, which are all of small or modest size, cod, haddock and plaice/flounder/dab dominate. A few bones of the southern species, tub gurnard and meagre, from the 15th-16th centuries at St. Clara are of note, as is the presence of common carp both at St. Clara (15th-16th centuries) and at Sarma (both periods).

Aalst: Holy Ghost Chapel (12)

Aalst is an inland town in eastern Flanders from where a small amount of fish bone material from the 14th century has been recovered by sieving. Both freshwater and marine species are present. The latter are represented by herring, haddock, plaice and flounder, species which are all well suited for preservation and transport. The presence of common carp is noteworthy, being among the oldest Belgian finds of this fish. Pieters *et al.* (1993) thought that the material represents a poor household since expensive fish such as cod, pike and common sole are absent.

Antwerpen: Burchtgracht, St. Ontcommer, Episcopal Palace, Guldenberg I, Zwartzusterstraat (13)

The city of Antwerpen is situated at the base of the Schelde estuary. Several fish bone assemblages, dating from the 14th-17th centuries AD, have been excavated here, the oldest being hand-collected and sieved material from the 14th century fill of the artificial ditch Burchtgracht. The others are: hand-collected material from the fill of an urban cesspit at St. Ontcommer (16th century); the sieved contents of refuse pits and cesspits at the Episcopal Palace (16th-17th centuries); hand-collected and sieved material from a refuse pit at Guldenberg I (16th-17th centuries); partly-sieved material from two pits in Medieval and post-Medieval houses in Zwartzusterstraat (16th-17th centuries).

Most of the fish bones in the Antwerpen material are from marine fish; in particular herring, cod, whiting, haddock and plaice/flounder/dab. Ling is present in the sample from the Episcopal Palace. The material from Zwartzusterstraat is slightly more varied than the others and contains, i.a., bones of European anchovy and garfish.

Heist (14)

A former fishing village on the coast. Sieved samples from 14th-16th century AD refuse pits and well fills have yielded one of Belgium's largest fish bone assemblages.

With the exception of seven examples, all the fish bones are from marine species, viz., thornback ray, herring, cod, whiting, haddock, saithe, ling, tub gurnard, bullrout, plaice and dab.

Sinaai, Boudelo Abbey (15)

Sinaai is situated ca. 50 km from the coast. Fish bone material was recovered by hand-collection during excavations at the abbey. The dating (14th-16th centuries AD) is rather tentative.

Most of the fish bones are from marine fish, viz., cod, haddock and plaice/flounder/dab. The representation of different skeletal elements indicates that entire gadids were imported to the abbey. The cod were 60-120 long, the haddock 30-60 cm (Gautier & Van Neer, 1991).

Raversijde (16)

An abandoned Medieval fishing village on a former island off the Belgian coast.

Van Neer & Ervynck (1994b) reviewed finds of fish bones from one of many excavated contexts at Raversijde (I). This find, dating from the 15th century AD, consists almost exclusively of marine fish: several species of cartilaginous fish and gadids, in addition to herring and many flatfish. There are only a few bones of eel and common carp.

Pieters *et al.* (1994) and Van Neer & Pieters (1997) reported on another find from 15th century Raverside (II) which turned out to be of a very special character. The material derives from a rubbish pit. Within the pit there was a lens (volume approximately 21 l) with a concentration of fish remains. The lens was sieved (series of meshes ranging from 2 to 0.25 mm), bones from the rest of the pit were hand-collected. The fish bones from the lens belong almost exclusively to plaice and represent a minimum of 130 individuals. The most interesting aspect of this find is that it comprises almost only bones from the head and tail. In addition, there are the shells of the bivalve *Donax vittatus* which are interpreted as fish stomach contents. Cutmarks behind the head and near the caudal fin are frequent. Apparently this find represents waste products from the processing of plaice. The narrow size range of the plaice indicate that they may have been intended for export. The material from the rest of the pit is interpreted as kitchen or table refuse. The single bone of common carp may be interpreted as evidence of import from the inland (Van Neer & Pieters, 1997).

Petegem, Beaulieu Abbey (17)

A site ca. 60 km from the coast, on the River Schelde.

A large refuse pit, probably dating back to the beginning of the 16th century, was excavated during a rescue excavation at the site of the former Beaulieu Abbey. Fish remains were hand-collected from among the household refuse. Most of the fish bones are from marine species, including thornback ray, cod, haddock, plaice/flounder/dab and sole (Van Neer & Ervynck, 1994b). Ervynck & Van Neer (1992b) interpreted the Beaulieu Abbey bones as refuse from a not very wealthy kitchen because expensive fish species are absent. Fish consumption seems to have depended entirely upon import of marine fish.

BELGIUM, OVERVIEW

Van Neer & Ervynck (1994b) have presented a detailed review of fish remains from Belgian archaeological sites. The interpretation of Belgian fishing in the present paper is very much based on their paper. Some newer publications have, however, also been incorporated. Another review paper on Belgian fishing is that of Van Neer & Ervynck (1994a). Ervynck & Van Neer (1995) discussed fish remains from Medieval castles, abbeys and towns in Flanders.

The Belgian fish bone material reviewed here covers the period from the 1st to the 17th centuries AD and represents many different types of sites. The Roman sites form a category of their own, as opposed to the Medieval sites, which include fishing villages on the coast, inland towns, abbeys, monasteries and castles.

Local influences on Belgian fishing

Belgian sites are generally dominated by marine species, except the Roman sites which are also the oldest. Among the marine species, gadids, plaice/flounder/dab, and herring in particular were important. The gadids are primarily represented by cod and haddock, but there are also more whiting than seen in other countries (an explanation for this is not obvious). It is characteristic that bones of herring are present in the sieved samples but absent from those which have merely been hand-collected.

There are a number of species on the Belgian species list which show that the country lies further south than those reviewed so far. Nursehound, which occurs in the material from the fishing village of Raversijde, has a southern distribution in Europe, occurring only irregularly north of the English Channel. Nursehound is a species of shark which frequents coastal waters to a depth of 60 m (Curry-Lindahl, 1985): it was thus within the reach of coastal fishermen. Other marine species with southern distributions are European anchovy, tub gurnard, European seabass, black sea bream, meagre and grey mullet. Several of these, for example, black sea bream, are common in the English Channel and further south. Black sea bream, European seabass and tub gurnard were found at Ieper, the latter also occurred at Diksmuide. These towns are located on the River Ijzer, the estuary of which lies close to the English Channel and is therefore more likely to receive the southern warm-water species than the more northerly River Schelde (Ervynck & Van Neer, 1995). European anchovy and tub gurnard also occur in some of the finds from the Netherlands, just north of Belgium. Meagre has also been found at some Dutch sites and is represented at one German site (Feddersen Wierde on the North Sea coast). The occurrence of thornback ray at no less than six Belgian sites is also noteworthy.

Quite a large number of freshwater species are represented, as a result of the inland location of most of the Belgian sites. The commonest of these are perch, cyprinids and pike. Barbel can be regarded as representing a more local element. The species of fish represented at the Belgian sites indicate both net and line fishing.

Remains of fishing tools from Belgian sites

Van Neer & Ervynck (1994a) mentioned a find of an eel trap from the Abbey of St. Salvator in Ename, as well as several net sinkers and a line sinker from Raversijde.

Fishing from Roman sites in Belgium

The samples from Tongeren, Braives and Namur (Place Marché aux Légumes, Saint-Gilles 3rd-5th centuries AD) are all from Roman settlements. At the same time, they represent the oldest Belgian assemblages in the considered period, being from the 1st-5th centuries AD, and will therefore be commented on separately.

All the Roman sites lie inland. Apart from Braives, from where freshwater fish are absent, and Tongeren where a single bone of a marine species was found, the Roman sites have yielded bones exclusively of freshwater fish, with a few remains of migratory species. The samples from Tongeren (Veemarkt) and Namur (Place Marché aux Légumes) are characterized by being composed of bones from very small individuals; more than 70% of the fish bones from Tongeren (Veemarkt) are from fish below 15 cm in standard length (Van Neer & Ervynck, 1994b). Regular exploitation of small freshwater fish seems to have taken place at the Roman sites. The material from Braives consists of even smaller fish: 4-5 cm in standard length, in this case exclusively marine species, especially clupeids, smelt and three-spined stickleback. Considering the size of these fish, and the difficulties it would have given to tranport them in a fresh state, Van Neer & Ervynck (1994b) interpreted this find as the remains of fish sauce, see also Van Neer & Lentacker (1994). In the material from Tongeren (Minderbroederstraat), a single bone of chub mackerel was found which was interpreted as the remains of fish sauce or salted fish imported from the south (Vanderhoeven *et al.* 1994).

Towns, fishing villages, monasteries and castles

The material from the non-Roman sites in Belgium covers the 7th-17th centuries AD, the more recent part of the period being best represented.

A striking characteristic of these sites is the great importance of marine fish, which strongly dominate almost all the assemblages.

Naturally enough, the marine dominance is most pronounced in material from the coastal fishing villages of Heist and Raversijde. Not only do almost all fish remains from these sites represent marine species, but the range of marine species is also the most diverse. For instance, Raversijde is the only Belgian site where shark remains have been found. Heist has provided the only Belgian record of saithe, and ling is known only from Heist and one other site.

Even in the inland towns, the marine dominance is very obvious. This is true, for example, of Antwerpen and Gent on the River Schelde, and Ieper and Dijksmuide on the River Ijzer. The number of marine species is particularly high at the two latter sites (which are also closer to the sea than the others) and includes, for example, thornback ray, tub gurnard, European seabass and black sea bream. Further inland, the town of Namur is situated on the River Meuse and here freshwater fish appear to have been more important than marine species.

Although most of the material from monastery and castle sites is dominated by marine species, Van Neer & Ervynck (1994b) believed that freshwater fish were exploited to a greater degree in the castles and abbeys than in contemporaneous urban settlements. Freshwater (and migratory) fish, especially eel and common carp, actually dominate in the material from St. Salvator's Abbey at Ename. There were often special rules for food consumption in abbeys, giving particular importance to fish. The find of common carp from Ename is the largest find of its kind from Belgium and indicates carp rearing at this site. Bones of common carp occur regularly in material from Belgian urban, monastery, abbey and castle sites (Antwerpen, Brussels, Laarne, Londerzeel and Ename). Carp seem to have served the purpose of providing a stable supply of fish. The material from the castle at Laarne is supposed to derive from the servants' quarters, but that from Londerzeel is thought to give an impression of the general food consumption at the castle. Marine fish dominate here, but freshwater species also played an important role.

Indications of fish trade in Belgium

Marine fish could of course be caught by the inhabitants of the coastal sites but their occurrence inland must be the result of trade. All the Belgian inland sites lie near rivers, by which fish could have been transported from the coast. According to Van Neer & Ervynck (1994b), the fish bone evidence offers no possibility of dating the onset of the trade in marine fish because of the lack of early Medieval material. There are no marine species among the four fish bones from 7th-8th century Gent, whereas in 12th century Gent, marine fish seem to have been imported, because cod, haddock and plaice/flounder/dab are present. There are no remains of herring but then, sieving was not carried out. Similar indications of the import of marine fish are generally seen in all the material from the 12th century AD onwards, and imported fish appears to have been of great importance. Van Neer & Ervynck (1994b) believed that this large-scale importing of seafish inland should not be regarded as result of a culinary demand but rather as having been necessitated by the pollution of inland running waters, tax regulations, over-exploitation etc. At many of the sites it has also been noted that the freshwater fish which were exploited were extremely small. For instance, 10-25 cm long pike and 20-30 long eels were caught in Namur (Grognon), indicating intense exploitation, bordering on over-exploitation of the fish fauna (Van Neer & Lentacker, 1996; see also Ervynck *et al.*, 1999). Several of the freshwater species which are present in the Belgian material are now extinct in Belgium, viz., burbot, whitefish, wels and sturgeon. It should be noted that from the 12th century onwards, haddock is included in the seafish imported to Belgian inland sites.

St. Salvator's Abbey in Ename, far from the coast, could be mentioned as an example of the import of seafish, although freshwater fish dominate the bone material. A wide range of marine fish was imported to Ename: thornback ray, herring, cod, whiting, haddock, turbot, plaice, flounder and common sole.

Namur is another example, situated still further inland. The material from Namur, Grognon, includes fish bones from different chronological phases. The 12th century material includes a mere five herring bones, no gadids or flatfish. In the 15th-16th century material, by contrast, there are many herring bones plus a single cod bone. This trend continues into the 17th century which presents many bones of herring, cod and plaice/flounder/dab (Van Neer & Lentacker, 1996; this assemblage is not included in Table 5 as it falls outside the scope of the present paper). The cod from Grognon seem to represent remains of stockfish. A similar tendency is seen at nearby sites in the Meuse bassin, whereas in Flanders, the import of seafish started earlier. The reason for this discrepancy could be the long distance from Namur to the coast (Van Neer & Lentacker, 1996), but might also be due to a smaller need for marine fish in the Meuse bassin where the pressure on freshwater fish would have been less than in more densely populated Flanders (Ervynck *et al.*, 1999).

Transport of fish from the inland to the coast may be indicated by the find of a single bone of common carp at Raversijde (Van Neer & Pieters, 1997).

Evidence of the processing of fish constitutes, in turn, further evidence of trade. The Belgian material offers several examples of processing. The oldest of these is the Roman material from Tongeren, Minderbroederstraat, from where a bone of chub mackerel has been interpreted as being the remains of imported fish sauce or salted fish from southern countries (Vanderhoeven *et al.*, 1994), cf. the chapter "Indications of fish trade in the Netherlands" above. Van Neer & Ervynck (1994b) mentioned that from the second century AD onwards, the original Mediterranean fish sauce was replaced by a local product produced along the Atlantic coast of Gallia. The 3rd century material from Braives, another Roman site, supports this conclusion. It consists of bones of very small marine fish, 4.5 cm long, and is interpreted as the remains of fish sauce prepared from fish caught in the northeastern Atlantic (Van Neer & Ervynck, 1994b; Van Neer & Lentacker, 1994). Remains of herring, which appear to have had their gills removed, were found under the kitchen floor in St. Salvator's Abbey in Ename: bones from the shoulder region were consistently missing (Van Neer & Lentacker, 1994). A mass of remains of processed plaice has been found in the fishing village of Raversijde: thousands of bones from the head and tail, together with presumed stomach contents represented by bivalve shells. Pieters *et al.* (1994) and Van Neer & Pieters (1997) suggested that the plaice were processed for future consumption and export inland.

EASTERN ENGLAND, INDIVIDUAL SITES

The review is based on already published results plus one unpublished report from the part of England facing east to the North Sea (from the Scottish border in the north to the Straits of Dover in the south). For a few sites, the only dating available is a reference to the "Roman" period which corresponds to ca. 55 BC - ca. 440 AD (Morgan, 1984).

The site numbers refer to the map, Figure 7. See Table 6 for detailed species lists.

York, 46-54 Fishergate (1)

York is situated ca. 60 km from the coast, at the confluence of the Rivers Ouse and Foss in northeastern England. Fish bones were recovered during the period 1985-86 by sieving of bulk samples through a 2 mm mesh sieve. The bone material derives, i.a., from 8th-9th century AD deposits associated with a presumed Anglian trading settlement. The archaeological evidence suggests that it is improbable that the settlement was occupied long after the Viking capture of York in AD 866. The larger fish bones from these deposits showed evidence of having been gnawed by dogs and other scavengers and many of the samples derive from cess pits. Fish bones from some of the latter were found to be crushed or flattened and were interpreted as having been eaten by people. Fish bones were also found in deposits connected with a church and cemetery dated to the 11th-12th centuries AD, and in deposits from a Medieval priory of the Gilbertine order dated to the 12th-16th centuries. Finally, fish bone material dated to the 16th century AD is connected with the demolition of the priory. In addition, some fish bones were found together with traces of Roman agricultural activity (1st-2nd centuries AD); it has, however, been suggested that these were all or mostly contamination from overlying Medieval deposits. Fish bones from Fishergate were identified and recorded by A.K.G. Jones, *in* O'Connor (1991).

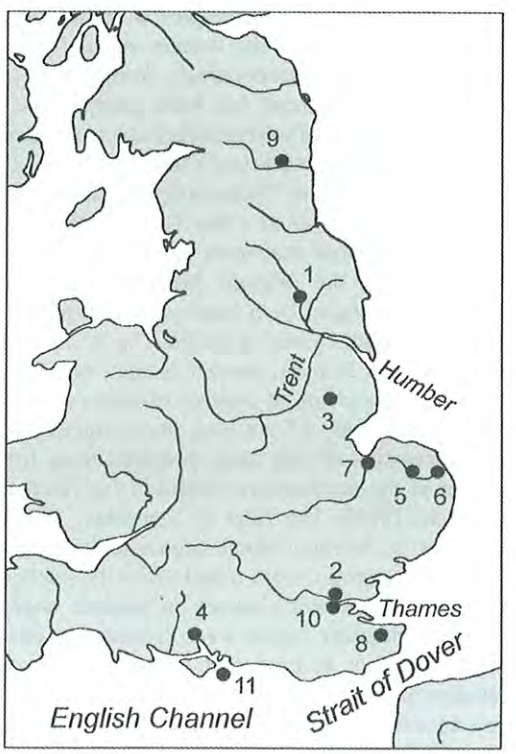

FIGURE 7

Map of eastern England, showing the location of the reviewed sites. Site numbers refer to the section "England, individual sites".

A wide range of fish species is present, from the site as a whole, including marine, migratory and freshwater species. Herring, eel and cyprinids seem to have been important during all periods.

The Anglian settlement (8th-9th centuries) relied heavily on eels. Cyprinids and herring were also of importance. Eel and herring were of equal importance in the 11th-12th century material. The abundance of cyprinids is less than in the previous period but then, gadids had achieved a certain importance. When the priory was in use herring was the most abundant species, whereas gadids were still of only moderate importance. In the youngest material (16th century) the importance of cod is greater, herring is still important but the cyprinids are far less significant. The general tendency thus seems to be a development from primarily eels and secondarily cyprinids during the 8th-9th centuries, to a more intense exploitation of herring during the 11th-12th centuries and an increase in the importance of gadids during the 12th-16th centuries, when the priory was in use and subsequently demolished.

The older phases in the material include species characteristic of rivers and estuaries, such as shad, grayling, barbel and burbot, whereas the younger phases include offshore marine species like thornback ray, conger eel, turbot and halibut.

Site	York, Fishergate	York, Fishergate	York, Fishergate	York, Fishergate	York, Fishergate	York, Church Street	York, Skelder-gate
Site no. (Fig. 7)	1	1	1	1	1	1	1
Age (centuries)	1-2 AD	8-9 AD	11-12 AD	12-16 AD	16 AD	"Roman"	"Roman"
Recovery technique	s	s	s	s	s	s	s
MARINE SPECIES							
Dogfish	-	-	2	-	-	-	-
Spurdog	-	-	-	-	-	-	-
Common stingray	-	-	-	-	-	-	-
Thornback ray	-	-	-	6	19	-	-
Ray, unspecified	-	-	1	-	9	-	-
Cartilaginous fishes, unspecified	1	-	2	1	14	-	-
Herring	50	714	716	685	1273	-	-
Herring/Sprat	-	-	-	-	-	-	
Sprat	-	-	-	-	-	-	-
Clupeids, unspecified	-	-	-	-	-	-	+
Conger eel,	-	-	-	1	2	-	-
Garfish	-	-	-	-	-	-	-
Hake	-	-	-	-	-	-	-
Gadids, total	2	31	79	181	781	-	-
Cod	-	17	50	51	111	-	-
Haddock	1	3	7	62	432	-	-
Whiting	1	1	-	47	176	-	-
Pollack	-	-	-	-	-	-	-
Saithe	-	-	-	-	-	-	-
Ling	-	-	-	4	13	-	-
Five-bearded rockling	-	-	-	-	-	-	-
Gadids, unspecified	-	10	22	17	49	-	-
John Dory	-	-	-	-	-	-	-
European sea bass	-	-	-	-	-	-	-
Atlantic horse-mackerel	-	1	2	-	-	-	-
Black sea bream	-	-	-	-	-	-	-
Common sea bream	-	-	-	-	-	-	-
Common pandora	-	-	-	-	-	-	-
Read Sea bream	-	-	-	-	-	-	-
Black sea bream	-	-	-	-	-	-	-
Common sea bream	-	-	-	-	-	-	-
Common pandora	-	-	-	-	-	-	-
Read Sea bream	-	-	-	-	-	-	-
Gilt-head sea bream	-	-	-	-	-	-	-
Seabreams, unspecified	-	-	-	-	-	-	-
Ballan wrasse	-	-	-	-	-	-	-
Wrasses, unspecified	-	-	-	-	-	-	-
Sandeel	-	-	-	-	-	-	-
Grey mullets, unspecified	-	-	-	-	-	-	-
Atlantic mackerel	-	-	-	-	46	-	-
Butterfish	-	-	-	-	-	-	-
Gobiids, unspecified	-	-	-	-	-	-	-
Tub gurnard	-	-	-	-	-	-	-
Grey gurnard	-	-	-	-	-	-	-
Red gurnard	-	-	-	-	-	-	-
Gurnards, unspecified	-	-	-	-	2	-	-
Three-spined stickleback	-	-	-	-	2	1	-

TABLE 6

Numbers of identified fish bones from eastern English sites. Recovery technique: h = hand-collected, s = sieved, ? = unknown.

Site	York, Fishergate	York, Fishergate	York, Fishergate	York, Fishergate	York, Fishergate	York, Church Street	York, Skelder-gate
Site no.	1	1	1	1	1	1	1
Age (centuries)	1-2 AD	8-9 AD	11-12 AD	12-16 AD	16 AD	"Roman"	"Roman"
Recovery technique	s	s	s	s	s	s	s
Flatfishes, total	-	91	11	40	85	-	+
Turbot	-	-	-	-	1	-	-
Halibut	-	-	-	1	2	-	-
Dab	-	-	-	-	-	-	-
Plaice	-	-	-	6	4	-	-
Flounder	-	9	1	1	2	-	-
Plaice/Flounder/Dab	-	82	10	32	76	-	-
Witch	-	-	-	-	-	-	-
Lemon sole	-	-	-	-	-	-	-
Common sole	-	-	-	-	-	-	-
Flatfishes, unspecified	-	-	-	-	-	-	+
Anglerfish	-	-	-	-	-	-	-
MIGRATORY SPECIES							
Sturgeon	-	-	-	1	1	-	-
Shad	-	52	4	7	-	-	-
Salmon	-	28	4	5	15	-	-
Trout	-	15	2	4	2	-	-
Salmon/Trout	-	-	-	-	-	-	-
Whitefish	-	1	-	-	-	-	-
Salmonids, unspecified	-	15	4	4	1	-	-
Smelt	-	16	11	11	19	82	-
Eel	10	3582	729	371	361	29	+
FRESHWATER SPECIES							
Grayling	-	12	-	5	-	-	-
Pike	1	72	23	27	12	-	-
Cyprinids, total	-	918	73	105	164	6+	-
Common carp	-	-	-	-	-	-	-
Gudgeon	-	2	-	-	-	-	-
Barbel	-	4	1	2	-	-	-
Bleak	-	-	-	-	-	1	-
Tench	-	-	-	-	-	-	-
Dace	-	-	-	-	-	-	-
Chub	-	1	1	1	3	-	-
Dace/Chub	-	2	-	1	-	-	-
Roach	-	1	-	1	9	2	-
Rudd	-	-	-	-	-	-	-
Common Bream	-	-	-	-	-	-	-
White bream	-	-	-	-	-	-	-
Stone loach	-	-	-	-	-	-	-
Bitterling	-	-	-	-	-	-	-
Cyprinids, unspecified	-	908	71	100	152	3+	-
Burbot	-	5	1	2	1	-	-
Perch	-	2	7	1	1	5	+
Ruffe	-	-	-	-	-	-	-
Percids, unspecified	1	1	3	8	7	-	-
Bullhead	-	-	-	-	-	-	-
TOTAL	65	5555	1674	1465	2817	126+	+

TABLE 6 (cont.)

Numbers of identified fish bones from eastern English sites. Recovery technique: h = hand-collected, s = sieved, ? = unknown.

Site	York, St. Mary Bishophill Junior	York, Coppergate	York, Coppergate	York, Coppergate	York, Coppergate	York, Coppergate	York, Coppergate
Site no. (Fig. 7)	1	1	1	1	1	1	1
Age (centuries)	3-10 AD	9-10 AD	10 AD	10-11 AD	11 AD (early-mid)	11 AD (late)	12 AD
Recovery technique	?	h+s	h+s	h+s	h+s	h+s	h+s
MARINE SPECIES							
Dogfish	-	-	-	-	-	-	-
Spurdog	-	-	-	-	-	-	-
Common stingray	-	-	-	-	-	-	-
Thornback ray	-	-	-	+	+	-	+
Ray, unspecified	-	-	-	-	-	-	+
Cartilaginous fishes, unspecified	-	-	-	-	-	-	-
Herring	41	+	+	+	+	-	+
Sprat	13	+?	-	-	-	-	-
Herring/Sprat	5702	-	-	-	-	-	-
Clupeids, unspecified	-	+	+	-	-	-	-
Conger eel,	-	-	-	-	-	-	-
Garfish	-	-	-	-	-	-	-
Hake	-	-	-	-	-	-	-
Gadids, total	1	+	+	+	+	+	+
Cod	-	+	+	+	+	+	+
Haddock	-	-	-	-	+	+	+
Whiting	1	-	+	-	-	-	-
Pollack	-	-	-	-	-	-	-
Saithe	-	-	-	-	-	-	-
Ling	-	-	-	-	-	+	+
Fivebearded rockling	-	-	-	-	-	-	-
Gadids, unspecified	-	-	+	+	+	-	+
John Dory	-	-	-	-	-	-	-
European sea bass	-	-	-	-	-	-	-
Atlantic horsemackerel	-	+	-	-	+	-	-
Black sea bream	-	-	-	-	-	-	-
Common sea bream	-	-	-	-	-	-	-
Common pandora	-	-	-	-	-	-	-
Read Sea bream	-	-	-	-	-	-	-
Gilt-head sea bream	-	-	-	-	-	-	-
Seabreams, unspecified	-	-	-	-	-	-	-
fBallan wrasse	-	-	-	-	-	-	-
Wrasses, unspecified	-	-	-	-	-	-	-
Sandeel	-	-	-	-	-	-	-
Grey mullets, unspecified	-	-	-	-	-	-	-
Atlantic mackerel	-	+	-	-	+	-	-
Butterfish	-	-	-	-	-	-	-
Gobiids, unspecified	-	-	-	-	-	-	-
Tub gurnard	-	-	-	-	-	-	-
Grey gurnard	-	-	-	-	-	-	-
Red gurnard	-	-	-	-	-	-	-
Red gurnard	-	-	-	-	-	-	-
Gurnards, unspecified	-	-	-	-	-	-	-
Threespined stickleback	-	+	+	-	-	-	-

TABLE 6 (cont.)

Numbers of identified fish bones from eastern English sites. Recovery technique: h = hand-collected, s = sieved, ? = unknown.

Site	York, St. Mary Bishophill Junior	York, Copper-gate	York, Copper-gate	York, Copper-gate	York, Copper-gate	York, Copper-gate	York, Copper-gate
Site no.	1	1	1	1	1	1	1
Age (centuries)	3-10 AD	9-10 AD	10 AD	10-11 AD	11 AD (early-mid)	11 AD (late)	12 AD
Recovery technique	?	h+s	h+s	h+s	h+s	h+s	h+s
Flatfishes, total	-	+	+	+	-	-	+
Turbot	-	-	-	-	-	-	-
Halibut	-	-	-	-	-	-	-
Dab	-	-	-	-	-	-	-
Plaice	-	-	-	-	-	-	+
Flounder	-	+	+	+?	-	-	-
Plaice/Flounder/Dab	-	-	-	-	-	-	-
Witch	-	-	-	-	-	-	-
Lemon sole	-	-	-	-	-	-	-
Common sole	-	-	-	-	-	-	-
Flatfishes, unspecified	-	+	+	+	-	-	+
Anglerfish	-	-	-	-	-	-	-
MIGRATORY SPECIES							
Sturgeon	-	-	+	-	-	-	-
Shad	-	+	+	-	-	-	-
Salmon	-	+	+	+	+	-	-
Trout	-	+	+	+	+	-	-
Salmon/Trout	-	-	-	-	-	-	-
Whitefish	-	-	-	-	-	-	-
Salmonids, unspecified	-	+	+	+	+	+	-
Smelt	-	+	+	+	+	-	-
Eel	-	+	+	+	+	-	+
FRESHWATER SPECIES							
Grayling	-	+	+	-	-	-	-
Pike	-	+	+	+	+	-	+
Cyprinids, total	-	+	+	+	+	-	+
Common carp	-	-	-	-	-	-	-
Gudgeon	-	-	+?	-	+?	-	-
Barbel	-	-	+	-	-	-	-
Bleak	-	-	-	-	-	-	-
Tench	-	+	+?	-	-	-	-
Dace	-	+	+?	+?	-	-	-
Chub	-	+	+	+?	-	-	-
Dace/Chub	-	-	-	-	-	-	-
Roach	-	+	+	+	+?	-	+
Rudd	-	-	+?	-	-	-	-
Common Bream	-	-	+?	-	-	-	-
White bream	-	-	-	-	-	-	-
Stone loach	-	-	-	-	-	-	-
Bitterling	-	-	-	-	-	-	-
Cyprinids, unspecified	-	+	+	+	+	-	+
Burbot	-	+	+	+	-	-	-
Perch	-	+	+	+	+	-	+
Ruffe	-	-	-	-	-	-	-
Percids, unspecified	-	+	+	-	-	-	-
Bullhead	-	-	-	-	-	-	-
TOTAL	5757	+	+	+	+	+	+

TABLE 6 (cont.)

Numbers of identified fish bones from eastern English sites. Recovery technique: h = hand-collected, s = sieved, ? = unknown.

Site	York, Copper-gate	York, Tanner Row	York, The Bedern	York, 1-5 Aldwark	London, Peninsular House	London, Westmin-ster Abbey	London, Westmin-ster Abbey
Site no. (Fig. 7)	1	1	1	1	2	2	2
Age (centuries)	13 AD	12-13 AD	13- AD	15-16 AD	2-4 AD	11-13 AD	15-16 AD
Recovery technique	h+s	h+s	h(+s)	?	s	h+s	h+s
MARINE SPECIES							
Dogfish	-	-	-	-	-	-	-
Spurdog	-	-	-	-	-	-	-
Common stingray	-	-	-	-	-	-	-
Thornback ray	+	-	+	-	-	2	-
Ray, unspecified	-	-	-	-	-	-	-
Cartilaginous fishes, unspecified	-	-	-	-	-	1	-
Herring	+	+	+	-	+	91	-
Sprat	-	-	-	-	+	-	-
Herring/Sprat	-	-	-	-	-	-	-
Clupeids, unspecified	-	-	-	-	-	-	-
Conger eel,	-	+	+	+	-	14	1
Garfish	-	-	-	-	-	-	-
Hake	-	-	-	-	-	-	-
Gadids, total	+	+	+	+	-	107	6
Cod	+	+	+	+	-	21	4
Haddock	+	+	+	+	-	17	1
Whiting	+	+	+	-	-	69	-
Pollack	-	-	-	-	-	-	-
Saithe	-	-	+	-	-	-	-
Ling	+	+	+	+	-	-	1
Fivebearded rockling	-	-	-	-	-	-	-
Gadids, unspecified	+	+	+	+	-	-	-
John Dory	-	-	-	-	-	1	-
European sea bass	-	-	-	-	+	5	-
Atlantic horsemackerel	-	-	-	-	-	-	-
Black sea bream	-	-	-	-	-	-	-
Common sea bream	-	-	-	-	-	-	-
Common pandora	-	-	-	-	-	-	-
Read Sea bream	-	-	-	-	-	-	-
Gilt-head sea bream	-	-	-	-	-	-	-
Seabreams, unspecified	-	+	-	-	-	-	-
Ballan wrasse	-	-	-	-	-	-	-
Wrasses, unspecified	-	-	-	-	-	-	-
Sandeel	-	-	-	-	+	-	-
Grey mullets, unspecified	-	-	-	-	-	-	-
Atlantic mackerel	-	-	-	-	-	1	-
Butterfish	-	-	-	-	-	-	-
Gobiids, unspecified	-	-	-	-	-	-	-
Tub gurnard	-	-	-	-	-	-	-
Grey gurnard	-	-	-	-	-	-	-
Red gurnard	-	-	-	-	-	-	-
Gurnards, unspecified	-	-	+	-	-	2	-
Threespined stickleback	-	-	-	-	-	-	-

TABLE 6 (cont.)

Numbers of identified fish bones from eastern English sites. Recovery technique: h = hand-collected, s = sieved, ? = unknown.

Site	York, Copper-gate	York, Tanner Row	York, The Bedern	York, 1-5 Aldwark	London, Peninsular House	London, Westmin-ster Abbey	London, Westmin-ster Abbey
Site no.	1	1	1	1	2	2	2
Age (centuries)	12 AD	12-13 AD	13- AD	15-16 AD	2-4 AD	11-13 AD	15-16 AD
Recovery technique	h+s	h+s	h(+s)	?	s	h+s	h+s
Flatfishes, total	+	+	+	+	+	101	4
Turbot	-	-	-	+	-	3	-
Halibut	-	-	+	-	-	-	-
Dab	-	-	-	-	-	-	-
Plaice	+	-	+	-	-	8	-
Flounder	-	+	-	-	-	4	-
Plaice/Flounder/Dab	-	-	-	-	+	-	-
Witch	-	-	+	-	-	-	-
Lemon sole	-	-	-	-	-	-	-
Common sole	-	-	+	-	-	13	-
Flatfishes, unspecified	+	+	+	-	-	73	4
Anglerfish	-	-		-	-	-	-
MIGRATORY SPECIES							
Sturgeon	-	-	-	-	-	3	-
Shad	-	+	-	-	-	1	-
Salmon	+	+	-	-	-	-	-
Trout	-	+	-	-	-	-	-
Salmon/Trout	-	-	-	-	-	-	-
Whitefish	-	-	-	-	-	-	-
Salmonids, unspecified	+	+	-	-	-	-	-
Smelt	-	+	-	-	-	3	-
Eel	+	+	-	-	-	28	1
FRESHWATER SPECIES							
Grayling	-	+	-	-	-	-	-
Pike	+	+	+	-	-	4	-
Cyprinids, total	+	+	+	-	-	12	-
Common carp	-	-	+	-	-	-	-
Gudgeon	-	-	-	-	-	-	-
Barbel	-	-	-	-	-	-	-
Bleak	-	-	-	-	-	-	-
Tench	-	-	-	-	-	-	-
Dace	+	-	-	-	-	-	-
Chub	-	-	-	-	-	-	-
Dace/Chub	-	-	-	-	-	-	-
Roach	+	+	+	-	-	-	-
Rudd	-	+	-	-	-	-	-
Common Bream	-	-	-	-	-	-	-
White bream	-	-	-	-	-	-	-
Stone loach	-	-	-	-	-	-	-
Bitterling	-	-	-	-	-	-	-
Cyprinids, unspecified	+	+	+	-	-	12	-
Burbot	-	+	-	-	-	-	-
Perch	+	+	+	-	-	-	-
Ruffe	-	-	-	-	-	-	-
Percids, unspecified	+	+	-	-	-	-	-
Bullhead	-	-	-	-	-	-	-
TOTAL	+	+	+	+	+	376	12

TABLE 6 (cont.)

Numbers of identified fish bones from eastern English sites. Recovery technique: h = hand-collected, s = sieved, ? = unknown.

Site	Lincoln, waterfront	Lincoln, waterfront	Lincoln, waterfront	Lincoln, waterfront	South-ampton, Mel-bourne St.	Norwich, Alms Lane	Norwich, Alms Lane
Site no. (Fig. 7)	3	3	3	3	4	5	5
Age (centuries)	3 AD	4 AD	9-11 AD	11-16 AD	7-8 AD	11-13 AD	13-16 AD
Recovery technique	s	s	s	s	s	s	s
MARINE SPECIES							
Dogfish	-	-	-	-	-	-	-
Spurdog	-	-	-	-	-	-	3
Common stingray	-	-	-	-	+	-	-
Thornback ray	-	-	-	1	+	9	25
Ray, unspecified	-	-	-	-	-	-	-
Cartilaginous fishes, unspecified	-	-	-	-	+	4	21
Herring	-	-	-	-	-	224	1124
Sprat	-	-	-	-	-	-	5?
Herring/Sprat	-	-	-	-	-	-	-
Clupeids, unspecified	-	-	-	2	-	-	115
Conger eel,	-	-	-	-	-	-	-
Garfish	-	-	-	-	-	-	-
Hake	-	-	-	-	-	-	-
Gadids, total	-	-	2	11	+	54	322
Cod	-	-	-	-	+	37	105
Haddock	-	-	2	-	-	-	6
Whiting	-	-	-	-	+	15	184
Pollack	-	-	-	-	+	-	-
Saithe	-	-	-	-	-	-	-
Ling	-	-	-	-	-	-	4
Fivebearded rockling	-	-	-	-	-	-	-
Gadids, unspecified	-	-	-	11	-	2	23
John Dory	-	-	-	-	-	-	-
European sea bass	-	-	-		+	-	-
Atlantic horsemackerel	-	-	-		+	-	1
Black sea bream	-	-	-	-	-	-	-
Common sea bream	-	-	-	-	-	-	-
Common pandora	-	-	-	-	-	-	-
Read Sea bream	-	-	-	-	-	-	-
Gilt-head sea bream	-	-	-	-	+	-	-
Seabreams, unspecified	-	-	-	-	-	-	-
Ballan wrasse	-	-	-	-	-	-	-
Wrasses, unspecified	-	-	-	-	-	-	-
Sandeel	11	29	-	-	-	-	-
Grey mullets, unspecified	-	-	-	-	+	-	-
Atlantic mackerel	-	-	-	-	+	8	16
Butterfish	-	-	-	-	-	-	-
Gobiids, unspecified	-	-	-	-	-	-	-
Tub gurnard	-	-	-	-	-	-	-
Grey gurnard	-	-	-	-	-	-	-
Red gurnard	-	-	-	-	-	-	-
Gurnards, unspecified	-	-	1	-	-	1	-
Threespined stickleback	-	-	3	-	-	-	-

TABLE 6 (cont.)

Numbers of identified fish bones from eastern English sites. Recovery technique: h = hand-collected, s = sieved, ? = unknown.

Site	Lincoln, waterfront	Lincoln, waterfront	Lincoln, waterfront	Lincoln, waterfront	South-ampton, Mel-bourne St.	Norwich, Alms Lane	Norwich, Alms Lane
Site no.	3	3	3	3	5	5	5
Age (centuries)	3 AD	4 AD	9-11 AD	11-16 AD	7-8 AD	11-13 AD	13-16 AD
Recovery technique	s	s	s	s	s	s	s
Flatfishes, total	3	10	-	3	+	6	72
Turbot	-	-	-	-	-	-	-
Halibut	-	-	-	-	-	-	-
Dab	-	-	-	-	-	-	-
Plaice	-	-	-	-	+	-	3
Flounder	-	-	-	-	+	-	-
Plaice/Flounder/Dab	-	-	-	-	-	6	64
Witch	-	-	-	-	-	-	-
Lemon sole	-	-	-	-	-	-	-
Common sole	-	-	-	-	-	-	5
Flatfishes, unspecified	3	10	-	3	-	-	-
Anglerfish	-	-	-	-	-	-	-
MIGRATORY SPECIES							
Sturgeon	-	-	-	-	-	-	-
Shad	-	-	-	-	-	-	-
Salmon	-	2	-	-	+	-	-
Trout	-	-	-	-	-	-	-
Salmon/Trout	-	1	3	8	-	-	-
Whitefish	-	-	-	-	-	-	-
Salmonids, unspecified	1	-	-	-	-	1	-
Smelt	-	-	2	-	-	-	-
Eel	22	42	99	66	+	13	111
FRESHWATER SPECIES							
Grayling	-	-	1	-	-	-	-
Pike	4	4	18	4	-	-	3
Cyprinids, total	96	60	317	115	-	-	22
Common carp	1	-	-	1	-	-	-
Gudgeon	-	-	-	-	-	-	-
Barbel	-	-	-	-	-	-	-
Bleak	-	-	-	-	-	-	-
Tench	1	-	-	-	-	-	-
Dace	-	-	-	-	-	-	-
Chub	-	-	1	-	-	-	-
Dace/Chub	-	2	-	2	-	-	-
Roach	-	2	14	10	-	-	3
Rudd	-	-	3	-	-	-	-
Common Bream	1	-	3	2	-	-	-
White bream	-	-	1	-	-	-	-
Stone loach	6	-	-	-	-	-	-
Bitterling	-	1	-	-	-	-	-
Cyprinids, unspecified	87	55	295	100	-	-	19
Burbot	-	-	1	1	-	-	-
Perch	16	23	79	1	-	-	1
Ruffe	-	1	9	-	-	-	-
Percids, unspecified	1	-	5	-	-	-	-
Bullhead	-	1	-	-	-	-	-
TOTAL	154	173	541	212	+	320	1841

TABLE 6 (cont.)

Numbers of identified fish bones from eastern English sites. Recovery technique: h = hand-collected, s = sieved, ? = unknown.

Site	Norwich, White-friars St. Car Park	Great Yarmouth	King's Lynn	King's Lynn	Canter-bury, St. Gregory's Priory	Canter-bury, St. Gregory's Priory	Canter-bury, St. Gregory's Priory
Site no. (Fig. 7)	5	6	7	7	8	8	8
Age (centuries)	10-13 AD	11-13 AD	11-13 AD	13-14 AD	12-15 AD	14-15 AD	15-16 AD
Recovery technique	s	h+s	h	h	h	s	h
MARINE SPECIES							
Dogfish	-	-	-	-	-	-	-
Spurdog	-	+	-	-	-	-	-
Common stingray	-	-	-	-	-	-	-
Thornback ray	+	+	-	-	-	-	-
Ray, unspecified	-	-	-	+	2	-	3
Cartilaginous fishes, unspecified	+	+	-	-	-	-	-
Herring	287	+	-	-	94	1215	84
Sprat	-	-	-	-	-	-	-
Herring/Sprat	-	-	-	-	-	-	-
Clupeids, unspecified	-	-	-	-	-	-	-
Conger eel,	-	+	-	+	3	11	15
Garfish	-	+	-	-	-	-	-
Hake	-	-	-	+	-	-	-
Gadids, total	+	+	+	+	28	576	76
Cod	+	+	+	+	15	39	22
Haddock	-	+	+	+	3	9	4
Whiting	+	+	-	-	1	494	36
Pollack	-	-	-	-	-	-	-
Saithe	-	-	-	-	-	-	-
Ling	-	+	-	+	-	-	-
Fivebearded rockling	-	-	-	-	-	-	-
Gadids, unspecified	-	-	+	+	9	34	14
John Dory	-	-	-	-	-	-	-
European sea bass	+	+	-	-	-	9	-
Atlantic horsemackerel	+	+	-	-	-	-	-
Black sea bream	-	-	-	-	-	4	-
Common sea bream	-	-	-	-	-	3	-
Common pandora	-	-	-	-	-	1	-
Read Sea bream	-	-	-	-	-	2	-
Gilt-head sea bream	-	-	-	-	-	-	-
Seabreams, unspecified	-	-	-	-	-	-	-
Ballan wrasse	-	-	-	-	-	-	-
Wrasses, unspecified	-	-	-	-	-	-	-
Sandeel	-	-	-	-	-	-	-
Grey mullets, unspecified	-	-	-	-	1	88	2
Atlantic mackerel	+	+	-	-	-	-	-
Butterfish	-	-	-	-	-	-	-
Gobiids, unspecified	-	-	-	-	-	-	-
Tub gurnard	-	+	-	-	-	-	-
Grey gurnard	-	-	-	-	-	-	-
Red gurnard	-	-	-	-	-	1	-
Gurnards, unspecified	-	-	-	-	4	44	-
Threespined stickleback	-	-	-	-	-	-	-

TABLE 6 (cont.)

Numbers of identified fish bones from eastern English sites. Recovery technique: h = hand-collected, s = sieved, ? = unknown.

Site	Norwich, White-friars St. Car Park	Great Yarmouth	King's Lynn	King's Lynn	Canter-bury, St. Gregory's Priory	Canter-bury, St. Gregory's Priory	Canter-bury, St. Gregory's Priory
Site no.	5	6	7	7	8	8	8
Age (centuries)	10-13 AD	11-13 AD	11-13 AD	13-14 AD	12-15 AD	14-15 AD	15-16 AD
Recovery technique	s	h+s	h	h	h	s	h
Flatfishes, total	+	+	+	+	26	487	45
Turbot	-	+	-	-	-	-	1
Halibut	-	+	-	+	-	-	-
Dab	-	-	-	-	-	-	-
Plaice	+	+	+	+	3	10	41
Flounder	+	+	-	-	-	9	3
Plaice/Flounder/Dab	44	-	-	-	-	-	-
Witch	-	-	-	-	-	-	-
Lemon sole	-	-	-	-	-	4	-
Common sole	-	+	-	-	-	-	-
Flatfishes, unspecified	-	+	-	+	23	464	-
Anglerfish	-	-	-	-	-	-	-
MIGRATORY SPECIES							
Sturgeon	-	-	-	-	-	-	-
Shad	-	-	-	-	-	-	-
Salmon	-	-	-	-	-	-	-
Trout	1?	-	-	-	-	-	-
Salmon/Trout	-	-	-	-	-	-	-
Whitefish	-	-	-	-	-	-	-
Salmonids, unspecified	+	-	-	-	-	-	-
Smelt	-	-	-	-	-	-	-
Eel	26	+	-	-	-	171	11
FRESHWATER SPECIES							
Grayling	-	-	-	-	-	-	-
Pike	+	-	-	-	-	-	-
Cyprinids, total	+	-	-	-	1	140	-
Common carp	-	-	-	-	-	-	-
Gudgeon	-	-	-	-	-	-	-
Barbel	-	-	-	-	-	-	-
Bleak	-	-	-	-	-	-	-
Tench	-	-	-	-	-	-	-
Dace	-	-	-	-	-	7	-
Chub	+	-	-	-	-	-	-
Dace/Chub	-	-	-	-	-	-	-
Roach	+	-	-	-	-	-	-
Rudd	+	-	-	-	-	-	-
Common Bream	+	-	-	-	-	-	-
White bream	-	-	-	-	-	-	-
Stone loach	-	-	-	-	-	-	-
Bitterling	-	-	-	-	-	-	-
Cyprinids, unspecified	+	-	-	-	1	133	-
Burbot	-	-	-	-	-	-	-
Perch	-	-	-	-	-	-	-
Ruffe	-	-	-	-	-	-	-
Percids, unspecified	-	-	-	-	-	-	-
Bullhead	-	-	-	-	-	-	-
TOTAL	+	+	+	+	159	2752	236

TABLE 6 (cont.)

Numbers of identified fish bones from eastern English sites. Recovery technique: h = hand-collected, s = sieved, ? = unknown.

Site	Canterbury, St. Gregory's Priory	Newcastle, Quayside, Queen St.	Newcastle, Quayside, Queen St.	Newcastle, Quayside, The Crown Court Site	Newcastle, Quayside, The Crown Court Site	Newcastle, Quayside, The Crown Court Site	Little Pickle
Site no. (Fig. 7)	8	9	9	9	9	9	10
Age (centuries)	15-16 AD	13 AD	14-16 AD	13 AD	14-15 AD	15-16 AD	16 AD
Recovery technique	s	h+s	h+s	h+s	h+s	h+s	h+s
MARINE SPECIES							
Dogfish	-	-	-	-	-	-	-
Spurdog	-	-	-	-	-	-	-
Common stingray	-	-	-	-	-	-	-
Thornback ray	-	2	2	-	46	8	-
Ray, unspecified	3	1	2	-	28	2	3
Cartilaginous fishes, unspecified	-	-	-	-	2	-	-
Herring	1743	66	411	82	533	169	54
Sprat	-	-	-	-	-	-	-
Herring/Sprat	-	-	-	-	-	-	-
Clupeids, unspecified	-	2	30	-	22	1	-
Conger eel,	12	-	-	-	1	-	10
Garfish	-	-	1	-	-	-	-
Hake	-	-	-	-	1	-	-
Gadids, total	396	445	1338	124	883	661	833
Cod	30	150	180	25	85	70	+
Haddock	15	23	199	14	143	145	+
Whiting	300	3	272	4	172	102	+
Pollack	-	-	1	-	-	-	+
Saithe	-	32	17	23	14	21	+
Ling	-	67	88	12	40	20	+
Fivebearded rockling	-	-	-	-	5	-	-
Gadids, unspecified	51	170	581	46	424	303	-
John Dory	-	-	-	-	-	-	-
European sea bass	3	-	-	-	-	-	-
Atlantic horsemackerel	-	1	1	-	-	-	-
Black sea bream	-	-	-		-	-	-
Common sea bream	-	-	-	-	-	-	-
Common pandora	-	-	-	-	-	-	-
Read Sea bream	-	-	-	-	-	-	-
Gilt-head sea bream	-	-	-	-	-	-	-
Seabreams, unspecified	-	-	1	-	-	-	-
Ballan wrasse	-	-	1	-	-	-	-
Wrasses, unspecified	-	-	1	-	-	-	-
Sandeel	-	-	17	2	120	4	-
Grey mullets, unspecified	22	-	-	-	-	-	-
Atlantic mackerel	4	-	-	-	-	-	-
Butterfish	-	-	-	-	14	-	-
Gobiids, unspecified	-	-	-	-	4	-	-
Tub gurnard	-	-	-	-	-	1	-
Grey gurnard	-	1	17	2	5	41	-
Red gurnard	-	-	-	-	-	-	-
Gurnards, unspecified	78	2	13	2	9	16	60
Threespined stickleback	-	-	-	-	-	-	-

TABLE 6 (cont.)

Numbers of identified fish bones from eastern English sites. Recovery technique: h = hand-collected, s = sieved, ? = unknown.

Site	Canterbury, St. Gregory's Priory	Newcastle, Quayside, Queen St.	Newcastle, Quayside, Queen St.	Newcastle, Quayside, The Crown Court Site	Newcastle, Quayside, The Crown Court Site	Newcastle, Quayside, The Crown Court Site	Little Pickle
Site no.	8	9	9	9	9	9	10
Age (centuries)	15-16 AD	13 AD	14-16 AD	13 AD	14-15 AD	15-16 AD	16 AD
Recovery technique	s	h+s	h+s	h+s	h+s	h+s	h+s
Flatfishes, total	214	6	93	16	58	69	+
Turbot	-	-	2	-	-	-	-
Halibut	-	-	-	1	-	-	-
Dab	-	-	4	-	1	1	-
Plaice	9	-	31	3	6	8	+
Flounder	3	2	1	2	9	7	+
Plaice/Flounder/Dab	-	1	3	3	-	6	116
Witch	-	-	-	-	-	-	-
Lemon sole	5	1	10	-	-	-	-
Common sole	39	-	-	-	-	-	-
Flatfishes, unspecified	158	2	42	7	42	47	-
Anglerfish	-	-	-	-	1		-
MIGRATORY SPECIES							
Sturgeon	-	-	-	-	-	-	5
Shad	-	-	-	-	-	1	-
Salmon	-	-	-	-	-	-	-
Trout	-	-	-	-	-	-	-
Salmon/Trout	-	-	1	-	-	-	-
Whitefish	-	-	-	-	-	-	-
Salmonids, unspecified	-	-	-	-	1	-	6
Smelt	-	-	1?	-	3	-	-
Eel	48	3	20	2	16	5	5
FRESHWATER SPECIES							
Grayling	-	-	-	-	-	-	-
Pike	4	-	-	-	-	-	67
Cyprinids, total	89	-	-	-	-	-	61
Common carp	-	-	-	-	-	-	+
Gudgeon	-	-	-	-	-	-	-
Barbel	-	-	-	-	-	-	-
Bleak	-	-	-	-	-	-	-
Tench	1	-	-	-	-	-	+
Dace	-	-	-	-	-	-	-
Chub	-	-	-	-	-	-	-
Dace/Chub	-	-	-	-	-	-	-
Roach	-	-	-	-	-	-	-
Rudd	-	-	-	-	-	-	-
Common Bream	-	-	-	-	-	-	+
White bream	-	-	-	-	-	-	-
Stone loach	-	-	-	-	-	-	-
Bitterling	-	-	-	-	-	-	-
Cyprinids, unspecified	88	-	-	-	-	-	-
Burbot	-	-	-	-	-	-	-
Perch	-	-	-	-	-	-	-
Ruffe	-	-	-	-	-	-	-
Percids, unspecified	-	-	-	-	-	-	-
Bullhead	-	-	-	-	-	-	-
TOTAL	2616	529	1949	230	1747	979	1220

TABLE 6 (cont.)

Numbers of identified fish bones from eastern English sites. Recovery technique: h = hand-collected, s = sieved, ? = unknown.

Site	Mary Rose
Site no. (Fig. 7)	11
Age (centuries)	16 AD
Recovery technique	?
MARINE SPECIES	
Dogfish	-
Spurdog	-
Common stingray	-
Thornback ray	-
Ray, unspecified	-
Cartilaginous fishes, unspecified	-
Herring	-
Sprat	-
Herring/Sprat	-
Clupeids, unspecified	-
Conger eel,	170
Garfish	-
Hake	+
Gadids, total	+
Cod	3804
Haddock	+
Whiting	-
Pollack	+
Saithe	-
Ling	-
Fivebearded rockling	-
Gadids, unspecified	182
John Dory	-
European sea bass	-
Atlantic horsemackerel	-
Black sea bream	-
Common sea bream	-
Common pandora	-
Read Sea bream	-
Gilt-head sea bream	-
Seabreams, unspecified	-
Ballan wrasse	-
Wrasses, unspecified	-
Sandeel	-
Grey mullets, unspecified	-
Atlantic mackerel	-
Butterfish	-
Gobiids, unspecified	-
Tub gurnard	-
Grey gurnard	-
Red gurnard	-
Gurnards, unspecified	-
Threespined stickleback	-

Site	Mary Rose
Site no.	11
Age (centuries)	16 AD
Recovery technique	?
Flatfishes, total	-
Turbot	-
Halibut	-
Dab	-
Plaice	-
Flounder	-
Plaice/Flounder/Dab	-
Witch	-
Lemon sole	-
Common sole	-
Flatfishes, unspecified	-
Anglerfish	-
MIGRATORY SPECIES	
Sturgeon	-
Shad	-
Salmon	-
Trout	-
Salmon/Trout	-
Whitefish	-
Salmonids, unspecified	-
Smelt	-
Eel	-
FRESHWATER SPECIES	
Grayling	-
Pike	-
	-
Cyprinids, total	
Common carp	-
Gudgeon	-
Barbel	-
Bleak	-
Tench	-
Dace	-
Chub	-
Dace/Chub	-
Roach	-
Rudd	-
Common Bream	-
White bream	-
Stone loach	-
Bitterling	-
Cyprinids, unspecified	-
Burbot	-
Perch	-
Ruffe	-
Percids, unspecified	-
Bullhead	-
TOTAL	4193

TABLE 6 (cont.)

Numbers of identified fish bones from eastern English sites. Recovery technique: h = hand-collected, s = sieved, ? = unknown.

York, Church Street (1)

A modest number of fish bones were recovered from sediment sieved through a 0.6 mm mesh during a rescue excavation of a Roman sewer system. They were identified by A. Wheeler and published *in* Buckland (1976). With one exception, the fish bones are from small individuals of freshwater and migratory fishes, smelt being the best represented species. Wheeler (*in* Buckland, 1976) notices that such young fish often stay near the mouth of drainage ditches from where they may have penetrated upstream during flooding and may have stranded as the water receded. This find may thus represent a natural deposit with no connection to fishing.

York, Skeldergate (1)

Fish bones were recovered from ten samples from a Roman well plus two further samples of Roman age, possibly by sieving. They were identified by P.J. Spencer and P.A. Veilleux and published by Hall *et al.* (1980). The very few fish bones are all from small individuals.

York, St Mary Bishophill Junior (1)

Fish bones were excavated during the period 1961-67. The site lies within the Roman *colonia*. The fish remains formed the bulk of a layer on a floor. A 100 ml subsample was analyzed by Jones (1988a). No exact dating is available; the layer may date from any time from the late Roman period to the 10th century AD. Approximately 75% of the fish bones were from young herring (7-11 cm total length), approximately 25% were from sprat of the same size. It was estimated that the excavated material included 40,000 fish bones in total. According to Jones (1988a), the remains may be interpreted as evidence of a fish processing enterprise, perhaps the manufacturing of fish sauce during the end of the Roman or the early post-Roman period.

York, 16-22 Coppergate (1)

Fish bone material from the urban Anglo-Scandinavian occupation of York, dated to the mid-9th to mid-11th centuries AD, was recovered at 16-22 Coppergate, an artisans' quarter. Small numbers of fish bones were recovered by hand-collection and very large numbers by wet-sieving. The fish bones were sorted out from the 2 mm fraction. The preservation of bone in most contexts is recorded as very good. The fish bones were identified and recorded by A.K.G. Jones *in* O'Connor (1989).

Medieval deposits from 16-22 Coppergate mainly consist of levelling/dumps which appear to have been laid down during the late 11th-13th centuries AD. Fish bones from these deposits were recovered by hand-collection and by sieving; they were identified by A.K.G. Jones and published by Bond & O'Connor (1999).

The species list from Coppergate is very varied and includes marine, migratory as well as freshwater fish. The number of samples in which each species occurred has been recorded in O'Connor (1989) for the 9th-11th centuries material. On this basis, herring, salmonids, pike, cyprinids and eel are regarded as frequent during this period. Herring and eel in particular were heavily exploited throughout the Anglo-Scandinavian period. On the other hand, Jones/O'Connor believed that the importance of cyprinids and salmonids decreased during the latter phases of the Anglo-Saxon period, while the importance of gadids increased. This is interpreted as a shift in exploitation in the early 11th century from local rivers to the open sea. The fact that thornback ray occurs only in the younger layers whereas shad and grayling, for example, occur exclusively in the oldest ones, is in agreement with this interpretation. Even though herring is a marine species, the fish are known to shoal in inshore and estuarine waters during the summer months and could have been caught in the Humber estuary. Sturgeon, shad, salmon, trout, smelt, eel and flounder could also have been caught in estuarine waters. The presence of sturgeon should be noted, this species being rare in British waters nowadays. Burbot is even regarded as extinct in England today (Wheeler, 1992).

York, 24-30 Tanner Row (1)

Fish bones were recovered mainly from various deposits dated to 12th-13th century AD, identified by A.K.G. Jones and published in Bond & O'Connor (1999).

The long list includes marine, freshwater and migratory species.

York, The Bedern (1)

Fish bones were excavated from the remains of the college of the Vicars Choral of Yorkminster.

The material dates from 13th century AD onwards. Fish bones were mainly hand-collected; they were identified by A.K.G. Jones and published by Bond & O'Connor (1999).

Marine species dominate the rather long species list.

York, 1-5 Aldwark (1)

Fish bones were recovered from 15th-16th century AD deposits, identified by A.K.G. Jones and published in Bond & O'Connor (1999).

All fish bones in the material are from marine species.

London, Peninsular House (2)

Remnants of a fish processing plant have been found at the Roman waterfront in London. The plant was active from the mid-2nd to the ?early 4th centuries AD. A compact deposit consisting of silt, small fish bones and amphora sherds were found at the site. Two and a half kilograms of the layer were sampled and sieved through a 0.25 mm mesh. The residue (650 g) was composed entirely of small fish bones representing thousands of individuals. Herring comprised 84% of the bones, sprat 16%; in addition there were a few bones of other species. The herring and sprat were very small, maximum total length 8.3 cm.

Bateman & Locker (1982) who studied this sample proposed that it might represent a relatively small-scale fishing industry. The herring and sprat could have been whole fish pickled in brine in the amphora, or they could be remains of locally produced fish sauce.

London, Westminster Abbey (2)

London lies on the River Thames in southeastern England. Fish bone material has been excavated in the sub-vault of the misericorde of the Westminster Abbey. Fish bones were picked out by hand and in addition, soil was sieved through a 0.3 mm mesh. The material is referable to several phases which are here grouped into two periods, the 11th-13th and 15th-16th centuries AD. The fish bones were studied by Jones (1976) and represent 21 marine, estuarine and freshwater species. The former, in particular herring, gadids and flatfish are, however, by far the most numerous. Eel seems also to have been of great importance. Several of the species are considered as rare and highly valued food fish, viz., sturgeon, European seabass, turbot, common sole and in particular John Dory. With the exception of ling, all the species could have been caught in the Thames and its estuary, and the southern North Sea.

Lincoln (3)

Dobney *et al.* (1996) analyzed a range of fish bone assemblages representing a range of periods (3rd century AD to Late Medieval) and areas from Lincoln, ca. 50 km from the North Sea. Systematic sieving was employed at four waterfront sites, and the discussion below refers to this material.

A dominance of freshwater species (cyprinids, perch) and eel is a general trait throughout all considered periods. The bones of eel are all from very small individuals (elvers) and may represent a natural death assemblage.

The find of common carp from a Roman deposit in Lincoln (3rd century AD) represents the earliest known occurrence in the British Isles and suggests that the Romans introduced the carp to certain areas (Dobney *et al.*, 1996).

A remarkable trait of several Late Roman samples is a high concentration of bones of small clupeids and sandeel. These are not included in Dobney *et al.*'s table but in one analyzed sample they represent an estimated 2860 individuals. Dobney *et al.* (1996) suggest that these small fish bones might be remains of locally produced fish sauce although the material does not allow a firm conclusion.

The single bone of bitterling is also of outstanding interest. Dobney *et al.* (1996) emphasize that this find suggests a natural occurrence of bitterling in the British Isles, where it has till now been regarded as introduced (Wheeler, 1969; Holčík, 1999).

In addition to the waterfront sites discussed above, Dobney *et al.* (1996) reported on a small number of hand-collected fish bones from other sites. These are all from marine species: conger eel, garfish, gadids, turbot and halibut.

Southampton, Melbourne Street (4)

Fish bones were recovered, mainly by sieving of a pit in middle Saxon (7th-8th centuries AD) deposits. They were studied by Bourdillon & Coy (1980) who presented a species list, however wit-

hout numbers of bones. According to the authors, the most abundant fishes were eel, flounder, European seabass and mullet which could all have been caught in intertidal traps or kiddles.

Norwich, Alms Lane (5)

Norwich lies on the River Wensum, ca. 30 km from the English North Sea coast. Fish bone material from Medieval Norwich was recovered by sieving soil samples through a 1 mm mesh. The material has been divided into several phases, which are here collected in two main groups. The site was first a dumping ground for iron waste (AD 1000-1275), thereafter it developed into an intensely occupied area of the town (AD 1275-1600).

The list of fish species is varied and is dominated by marine species. Herring remains are particularly frequent, but there are also many remains of gadids, eel, flatfish and cartilaginous fish. The gadids are represented by cod, whiting, haddock and ling. The Medieval whiting were 26-60 cm long, the cod 45-105 cm. The presence of bones from both head and body suggests that whole fish were imported. A special sample is constituted by a pot, dated to AD 1274-1400, the fill of which contained remains of herring and herring/sprat. Eel seems to be the only local species which was consumed in any quantity. Pike, tench, roach, perch and three-spined stickleback occur in the River Wensum today. There is no sign of a temporal change in fish consumption (Jones & Scott, 1985).

Norwich, Whitefriars Street Car Park (5)

Fish remains were recovered by sieving from deposits which had accumulated on the riverbank; these are dated to the 10^{th}-13^{th} centuries AD. According to Jones (1983), herring is the most frequent species, remains of cod and whiting are more abundant than remains of cartilaginous fish, eel and flatfish and Atlantic mackerel, Atlantic horse mackerel and European seabass bones are uncommon. Remains of estuarine and freshwater fish are present at lower frequencies. Since the bones were collected from the river bank the possibility exists that some of the bones of freshwater fish could be from fish which died from natural causes. The sampled deposits contain refuse from a large number of households over unspecified periods of time but Jones (1983) emphasized that in spite of all reservations the assemblages illustrate the variety of fish in the diet of Medieval occupants of Norwich.

Great Yarmouth (6)

Great Yarmouth lies on the English North Sea Coast at approximately the same latitude as the inland town of Norwich. In 1974, fish bones were recovered by hand-collection and sieving of soil through a 1 mm mesh. The material was published by Wheeler & Jones (1976) as early Medieval (10^{th}-13^{th} centuries AD, R. Nicholson in litt.). The authors compared this material extensively with the, at least partly contemporaneous, material from Norwich. The species list is varied but is composed exclusively of marine species, plus the migratory eel. According to the authors, cod, whiting and Atlantic mackerel dominate throughout and probably were the most important species caught. Plaice also occurs in most samples, as do haddock, Atlantic horse mackerel and conger eel. The remaining species are represented by relatively few bones. The cod bones fall into two size classes. Wheeler & Jones (1976) suggested that this may represent local fishing for small cod and the importing of large ones.

King's Lynn (7)

A town on the north coast of Norfolk, situated at the mouth of the River Gt. Ouse where it enters the North Sea. Fish bones from Medieval King's Lynn were recovered by hand and dated to two phases covering the 11^{th}-14^{th} centuries AD. All the fish bones are from marine species. According to Wheeler (1977), numerous bones were identified as cod, which seems to have been the most important fish used for food at King's Lynn. In addition to cod, numerous bones of haddock, ling and plaice were recorded; the other species are only represented by one or two bones each. A striking feature of the material is that all bones are from large fish. The lack of small species, such as for instance herring and eel, may be a result of the recovery technique rather than their not having been consumed at the site. The total length of the fish was estimated to 80-140 cm for ling, 45-60 cm for haddock, and 55-142 cm for cod. The cod fall largely in two size classes: 60-80 cm and 80-137 cm. This perhaps reflects local fishing for smaller cod, probably during wintertime, and the import of large cod from the North. The large cod might, however, also have been caught by local fishermen fishing further afield. Bones from both the head and trunk of the cod are present.

Canterbury, St. Gregory's Priory (8)

Canterbury lies in extreme southeastern England, ca. 10 km from the North Sea. Excavations at the Medieval St. Gregory's Priory yielded a wealth of fish bones. Smith (unpublished) has presented a detailed report and discussion of these fish assemblages. The samples date from the 12th-16th century AD. In addition to hand-collected samples from various sites in the Priory there are two large sieved samples from the refectory (14th-15th century AD) and kitchen (15th-16th century AD); these contained so many fish bones that only 1/8 and 1/4 were analyzed, respectively.

All the samples are dominated by marine fish. Herring is by far the commonest species in the hand-collected samples, and in the sieved samples, its dominance is even more striking. Whiting bones are abundant, too, especially in the sieved samples. The southern location of Canterbury is reflected by the presence of European sea bass, grey mullet, tub gurnard and several species of sea breams. Based on four lines of evidence, viz., local availability of fish, butchery evidence, element representation and size distribution, Smith concluded that a combination of fresh and preserved fish were consumed at the priory. Some of the gadid remains bear evidence of deriving from stockfish. The numerous remains of whiting from the kitchen sample derive from specimens of a very uniform size (ca. 19 cm length), an indication that these had been processed. Remains of other species show much more size variation, indicating that they were taken fresh into the Priory.

Newcastle Quayside, Queen Street (9)

Newcastle lies on the River Tyne on England's northeast coast. Medieval fish bone material was excavated in the Quayside area, partly by handpicking, partly by sieving of bulk samples. The part of the material which is relevant for the present publication has been dated to the 13th-16th centuries AD. Twenty-one species of fish were identified in the material. Nearly all bones are from marine species, in addition there are a few estuarine or migratory species. The gadids seem to have been most important and are represented by cod, haddock, whiting, pollack, saithe and ling. There are also many herring bones, and flatfish seem to have been of some importance. The cod in the material were 35-ca.130 cm long, most of them being large. All the ling were more than 1 m long. Nicholson (1988) believed that fishing certainly took place in summer and autumn as shown by the presence of herring, garfish and large cod. Some of the smaller cod, as well as haddock, whiting, ling and flatfish, could have been caught in winter.

Newcastle Quayside, the Crown Court Site (9)

The fish remains are partly from inside buildings, and partly from outside areas with general rubbish. The material is referable to several phases. For the present review, indoor and outdoor samples have been pooled, and only three periods are recognized, viz. the 13th, 14th-15th, and 15th-16th centuries AD. As no temporal change is evident in the material, this does not result in loss of information. Fish bones were recovered by handpicking and predominantly from sieving of bulk residues. The species list is particularly varied. Virtually all the fish remains recovered are from marine species, gadids being by far the dominant group, followed by herring. The gadids are represented by cod, haddock, whiting, saithe and ling. Hake is also noteworthy. Both medium sized (35-75 cm) and large (>75 cm) cod are present. The ling were more than 1 m long, and the saithe around or over 1 m. The sizes of the gadids suggest that both deep sea and inshore fishing was practised. The variety of fish suggests that a range of fishing techniques was used, for example, nets and long lines with baited hooks (Nicholson, 1989).

Little Pickle, Surrey (10)

Little Pickle is situated south of London. Fish bones were excavated from a single well-preserved pit feature of Tudor date. The material is interpreted as kitchen waste and has been dated to the 16th century AD. The fish bones were recovered partly by hand-collection, partly by sieving through a 6 mm mesh. There are many species represented, marine, migratory and freshwater. Gadids seem to have been of the greatest importance; cod, haddock, whiting, pollack, saithe and ling are present. Flatfish and herring were also important, perhaps even more so than the material shows, as small fish must be regarded as underrepresented due to the large mesh size used during bone recovery. On the basis of the representation of skeletal elements the large individuals of cod, ling, haddock and saithe are thought to have been imported as preserved stockfish. The presence of sturgeon is taken as evidence of the high status of the household (Bullock, 1995).

Mary Rose (11)

The Tudor man-of-war Mary Rose sank in 1534 off Portsmouth in the English Channel. A large amount of fish bone material was retrieved from the orlop (or lowest) deck of the wreck. The fish bones are the remains of stores and thus provide a unique insight into the character of the fish supplies carried by ships at that time. Although Portsmouth lies marginally with regard to the scope of the present review, the Mary Rose material has been included (cf. Scheurrak SO1 under The Netherlands). The recovery method used for the fish bones was not given by Hamilton-Dyer (1995) who published the material. All in all, about 30,000 fish bones were found. Most of these were fin rays. Identification of the finrays was not attempted, but they are probably from cod because nearly all other bones are from this species. It is characteristic that bones from the head region are absent, as are the first ca. six vertebrae. The cleithrum, a shoulder girdle bone, is represented, but many of the cleithra were chopped. It thus seems that fish processing had at least included decapitation. In all probability the bones are remains of dried and/or salted cod, i.e. stockfish.

In addition to the numerous cod bones, there was a total of 37 bones from conger eel, hake, haddock and pollack. Hamilton-Dyer (1995) concluded that the remains seem to indicate the organized provision of specific types and amounts of fish as part of the regular diet on board naval ships.

EASTERN ENGLAND, OVERVIEW

The material from the eastern English sites covers the period from the 1st to the 16th centuries AD.

Local influences on English fishing

The English species lists are generally dominated by gadids, herring and eel. In addition there is an element reflecting local characteristics. The presence of southern species like European seabass, tub gurnard, red gurnard, John Dory and several species of sea breams thus agrees with southern England's location near warmer seas. Some of the other species found in the English materials, viz., conger eel, Ballan wrasse and fivebearded rockling are most common on rocky shores (the conger eel, however, also occurs offshore on rough ground, Wheeler, 1969). England has long stretches of rocky coast, although not along the southern half of the east coast where many of the sites are located. Thornback ray is the commonest species of ray in inshore waters along the East Anglian coast and is also relatively frequent in the eastern English material. In material from the other countries, with the exception of Belgium, it is much less abundant. Sandeels have similarly been found much more abundantly in England than in the other countries. The find of numerous bones of sandeel, together with bones of small clupeids, in Roman deposits in Lincoln, tempted Dobney *et al.* (1996) to an interpretation as remains of locally produced, Roman-type fish sauce. According to written sources, sandeels were of great importance in Medieval England (Nicholson, 1989). Maybe sandeels could be dug out on the long sandy stretches of tidal coast (suggestion by J. G. Nielsen who has tried this method in Denmark). The English material resembles that from Belgium with its large content of whiting bones.

Among the freshwater species, bitterling and burbot are of particular interest. Bitterling has been regarded as having been introduced to the British Isles during the 20th century (Holčík, 1999), but the find in 4th century deposits in Lincoln (Dobney *et al.*, 1996) suggests that it may have occurred naturally. Burbot used to have a very limited distribution in eastern England (Wheeler, 1969) and is possibly extinct in England today (Wheeler, 1992). The presence of barbel in English fish bone assemblages is also noteworthy, this species now having a very local and scattered distribution in eastern England (Wheeler, 1969). The find of common carp from 3rd century AD Roman deposits in Lincoln is by far the oldest record of this species in the region. According to Dobney *et al.* (1996) this find strongly supports the suggestion that the Romans introduced the common carp to certain areas as a prized food item and as an ornamental pond fish.

The large quantities of herring at the English sites suggests the widespread use of drift nets. The range of seafish species, in combination with the estimated sizes of the specimens caught, indicates that both inshore and deep sea fishing was practised from the 12th century onwards. European seabass, garfish, Atlantic horsemackerel and Atlantic mackerel indicate fishing during the summer and/or autumn. On the other hand, small cod indicate winter fishing, because these are more com-

mon close inshore along the English North Sea coast during winter. All in all, there is evidence for fishing all the year round in Viking Age and Medieval eastern England.

Differences between inland and coastal sites are evident. For instance, the coastal samples from Great Yarmouth, King's Lynn and Newcastle are totally devoid of freshwater fish.

Some samples represent refuse from high-status households. These include those from the 11th-12th century church and from the 12th-16th century priory of the St. Gilbertine Order (both from York), the fish remains from Westminster Abbey in London and the kitchen refuse from Little Pickle. Most of the few English finds of sturgeon, a rare and highly esteemed fish, are from this category of site. Westminster Abbey also contains remains of other highly esteemed fish species: European seabass, turbot, common sole and John Dory.

Remains of fishing tools from English sites

Fourty-five large iron fish-hooks (54-75 mm, one 122 mm) dated to the 11th-13th centuries have been found at Great Yarmouth. Hooks of this size would have been useful for catching large fish like spurdog, conger eel, ling, cod, large haddock or halibut, (cf. also the above discussion about import or local fishing at Great Yarmouth, Steane & Foreman, 1988). The Coppergate site at York produced ten fish-hooks of smaller size: 40-55 mm (Steane & Foreman, 1988). Hooks have also been found at Norwich; Jones & Scott (1985) reported a total of eight hooks, dated to the 14th-18th centuries.

In the wreck of Mary Rose, hand frames and floaters were found as part of the sailors' equipment, they were probably intended for supplying the diet with fresh fish.

Extensive fish weir complexes have been excavated in the River Trent at Colwick. The Trent empties into the Humber, the site is thus not too far away from York. One of the complexes has a calibrated radiocarbon date of AD 810-880, the other, AD 1070-1200. The latter complex was at least 100 m long (Losco-Bradley & Salisbury, 1979; Salisbury, 1988). These weir complexes were thus both in operation at the time of the settlements in York which are documented in the Fishergate and Coppergate bone assemblages. Fish weirs such as these have generally been used to catch eels and lamprey on their downstream migrations. As is evident from the species lists, eel were of particular importance. Just like today, fish weirs were probably also placed in estuaries and on tidal coasts in order to catch estuarine and inshore fish such as eel, salmon, trout, dab and flounder.

Indications of a chronological development and fish trade in eastern England

Chronological development in the exploitation of fish can be excellently illustrated using the material from York as an example. The Roman samples from York are mostly small and/or of dubious origin. The material from St. Mary Bishophill Junior, however, includes several thousand of bones of herring/sprat and may be interpreted as remains of locally produced of fish sauce.

Fishing during the Viking Age (8th-10th centuries) is very well documented at York. The material clearly indicates exploitation of local fish resources in rivers and the estuary, with eels and cyprinids being most frequent. There are also a good many remains of herring which may also have been caught in the estuary. After the Viking period, i.e., during the 11th-16th centuries, a shift towards greater exploitation of fish from the open sea seems to have taken place. Jones (1988b) noted a marked increase in species diversity in the bone assemblages from York from the 12th century AD onwards. The most striking feature is the larger content of gadid remains, but species such as thornback ray, conger eel, Atlantic mackerel and halibut also became important (O'Connor, 1989, 1991). An element of freshwater fish, present during all periods, is consistent with York's inland location. See Jones (1988b) for a discussion of further trends.

The Viking Age is not represented at the remaining English sites but the tendency for marine species to have been most important from the 11th century onwards is generally valid. However, different marine species dominate at different sites.

At Norwich, for instance, herring bones dominate, and all the marine species found here have also been found in the contemporaneous material from coastal Great Yarmouth. Jones & Scott (1985) assumed therefore that the marine fish found at Norwich were imported from Great Yarmouth.

Two size classes of cod are represented in the Great Yarmouth material. As large cod are nowadays uncommon off Great Yarmouth, Wheeler &

Jones (1976) suggested local fishing for small cod and the import of larger ones from northern waters. Alternatively, local fishermen may have caught large cod on fishing trips far away from home. The finds of large fish-hooks at Great Yarmouth are of relevance to this discussion. The presence of bones from the head as well as the trunk of the cod in the Norwich material suggests that if cod really was imported from Great Yarmouth to Norwich, then it was not in the form of stockfish.

The King's Lynn material also contains cod in two size classes (60-80 cm and 80-137 cm) and here too, both head and trunk bones are present (Wheeler, 1977).

Ling is another gadid which is generally present at sites from the 13th century onwards. Ling does not normally occur off the English North Sea coast and is therefore regarded as having been imported. According to Wheeler & Jones (1976), the same is true of halibut and possibly even large individuals of haddock. Large cod may have been more common in the southern part of the North Sea during the Middle Ages. There is, however, no reason to believe that this was also the case for ling and halibut and these must therefore be regarded as having been imported (Wheeler & Jones, 1976; Wheeler, 1977).

The import of stockfish seems to be indicated in the bone assemblages from Canterbury (14th-15th centuries AD) and Little Pickle (16th century) since several gadid species, viz., cod, ling, pollack and saithe are only represented by the shoulder girdle bone, cleithrum, and vertebrae. Other gadids, viz., whiting and haddock, do not show this bias in representation of skeletal elements (Bullock, 1995).

The finds from the shipwreck, the Mary Rose, prove that fish, especially cod, but also some conger eel, hake, haddock and pollack, were brought along as supplies. The representation of skeletal elements in the Mary Rose material shows that the fish were headless; they were probably dried and/or salted (Hamilton-Dyer, 1995).

REGIONAL OVERVIEW

Archaeo-osteological evidence for fishing in the southern North Sea region in the period from the 1st to the 16th century AD has been reviewed on a national basis in the preceding chapters. Evidence from a large number of sources has revealed some regional trends concerning the influence of local conditions on fishing and fishing methods. For the remaining discussion (seasonality and trade), fish bone evidence from sites in the Baltic area reviewed previously (Enghoff, 1999) is taken into consideration in order to reveal trends in fishing within this larger area in the period from the 5th century BC to the 16th century AD. Figure 8 shows the locations of all the Baltic and North Sea sites. Topics covered include the former distributions of fish species, the decline of sturgeon and other species, fishing seasons, and the chronological development of trade in fish.

When individual sites are referred to below outside a national context, the country in question is indicated with the same letter codes as those used in Table 1.

Local fishing for local fish in the North Sea region

The fish bone assemblages included in the present review contain species which could have occurred in local waters, suggesting that fishing was conducted locally. This is shown most clearly by species with a limited distribution in Europe which is reflected in the subfossil finds. Barbel is such a species, it has been found at Dutch, Belgian, English and Polish sites. Enghoff (1999) gave several other examples of species whose occurrence in the subfossil assemblages reflect their present-day distribution.

The proximity of the North Sea is reflected in the strong representation of gadids in the material treated here. Cod and haddock have been found in all of the countries; saithe, ling and whiting in most.

Corresponding to the abundance of herring bones at sites in the Baltic area and the famous seasonal herring fishing in Øresund (Enghoff, 1999), a striking profusion of herring bones also characterizes sites on the Belgian and English North Sea coasts. The North Sea is known to harbour several large herring stocks which through time have formed the basis of important herring fisheries (Jensen & Olsen, 1991). In England, the well-known East Anglian herring fishery is thought to have commenced about the year AD 495 (Wheeler & Jones, 1976). In this area, migration of herring resulted in seasonal exploitation and market activity each autumn (September-November), for instance in Great Yarmouth (Wheeler & Jones, 1989).

The English and Belgian sites flanking the southern North Sea show additional common traits. For instance, samples from these sites contain more remains of thornback ray and whiting than those from other countries, although both species are actually common along all North Sea coasts.

Several of the fish species seen in the assemblages are only common today as far north as the English Channel, for example the sea breams, red gurnard, nursehound and chub mackerel. Others, such as tub gurnard and European seabass, reach slightly further north. Material from the southernmost of the countries studied contains elements of species with similar distributions. In English material, the southern element is represented by John Dory, European seabass, red gurnard, tub gurnard and several species of bream. Belgian material has yielded nursehound, European anchovy, chub mackerel, tub gurnard, European seabass, black sea bream, meagre and grey mullet. Southern species from Dutch sites include smoothhound, common stingray, European seabass, meagre, striped red mullet, chub mackerel, barracuda, tub gurnard and European anchovy. The finds of chub mackerel and barracuda are, however, interpreted as deriving from imported fish.

Even Germany has records of three bones of meagre. The finds of meagre from The Netherlands and Germany are all dated to 4th century BC - 3rd century AD; perhaps this species occurred further north at this time. The Belgian find of meagre is dated to 15-16th centuries AD, but Belgium lies close to the English Channel which forms the northern boundary for the common occurrence of the species today (Curry-Lindahl, 1985).

Some of the southern species have been encountered at even more northerly sites, without there being any indication that they were not caught locally. This is true of smoothhound at Smedegaard (DK) and of thinlip grey mullet at Ribe (DK) (Enghoff, 1999).

The common carp

Common carp is an indigenous species in southeastern Europe but has been kept in aquaculture over much of central and western Europe. Common carp is represented in several bone assemblages from the region and period under consideration here; its bones are particularly plentiful in two of the samples from Ename (B). The oldest finds in the respective countries are: Poland, Wrocław 10th-14th centuries AD - Germany, Hitzacker (von den Driesch, 1982) 9th-10th centuries AD - The Netherlands, Leeuwarden 11-14th centuries AD - Belgium: Londerzeel and Laarne 13th-14th century AD - England, Lincoln 3rd century AD. See Hoffman (1994, 1995) for further details regarding the culture of common carp in Medieval Europe.

Sturgeon and other declining species

Species like pikeperch (*Stizostedion lucioperca*) are examples of the constancy of the geographical distributions of fish species (Enghoff, 1999). The subfossil assemblages also provide evidence of changes of distribution with time. Thus the migratory species sturgeon has been found at sites from all the countries covered here and thus can be assumed to have been widely distributed. As recently as in the 19th century sturgeon occurred commonly along the Baltic and North Sea coasts of Europe (Curry-Lindahl, 1985). In the 3rd century AD intense fishing for sturgeon took place at Feddersen-Wierde (D) where there even was a tool industry based on sturgeon bones. In the Middle Ages sturgeon was a highly esteemed fish reserved for the upper class. Based on German and Polish fish bone assemblages, Benecke (1986) documented a decline in sturgeon populations in the southern Baltic region in the course of the Middle Ages and ascribed this to overfishing. Nowadays, the sturgeon is regarded as extinct in the Baltic-North Sea region.

Similar, albeit less spectacular, examples of extralimital finds of fish which seem not to have been imported include wels and burbot. Wels was, i.a., found at some sites in Belgium and the south-central to southeastern Netherlands but is absent from this area nowadays (Heinrich, 1999b; Ervynck *et al.*, 1999), just as the find of wels at Birka (Enghoff, 1999) is slightly to the north of the present-day distribution in Sweden. (Brinkhuizen (1979b) showed that wels is native to an area in the western Netherlands). Burbot was found at a few English and Belgian sites but is now regarded as extinct in both countries.

Fishing methods

The variety of fish species found, especially at the coastal sites, suggests that fishing was conducted using a number of different methods. Nets, hook-and-line and fish weirs seem to have been most important.

NET FISHING

Jones (1981) wrote that "a likely explanation for the sudden rise in surfaceswimming, pelagic fish [herring, Atlantic mackerel and garfish] in the late Saxon period is the development of the East Anglian herring fishery, which used floating nets". Wheeler & Jones (1976), Jones (1983) and Nicholson (1989) also assumed surface nets to be the main tools for English herring fishing. In the Baltic area the extensive catches of herring were likewise supposed to have been secured by net fishing (Enghoff, 1999).

Fishing nets were of course used for catching many species other than herring. Other pelagic species likely to have been net-caught include Atlantic horsemackerel and European seabass (Wheeler & Jones, 1976). Also the numerous whiting in the English assemblages are assumed to have been net-caught (Nicholson, 1989). The same is probably true of the abundant Belgian finds of this pelagic shoaling species. Atlantic mackerel and garfish were probably net-caught, too, as seems to have been the case in the Baltic region (Enghoff, 1999).

The large finds of plaice/flounder/dab at Ribe (DK) and several other coastal sites further south may also represent results of net fishing [net sinkers have been found in Iron-Viking Age Ribe and in Raversijde (B)].

HOOK-AND-LINE FISHING

From most of the countries large individuals of gadids (cod, haddock, ling) and/or hake are known. These fish mainly occur in not-too-shallow waters close to the seabed and would have been most efficiently caught using hooks attached to long lines.

There are several examples of fish bone assemblages from countries on the North Sea containing the remains of large gadids, which are assumed to have been caught this way. For instance, they are present at the German North Sea sites of Feddersen Wierde and Elisenhof. The former site provides a remarkably early example of fishing for these large fish (3rd century AD). Eastern English assemblages with large cod, haddock and ling include Great Yarmouth and King's Lynn (both 11th-13th centuries AD). Finds of large fish-hooks at Great Yarmouth contribute to the picture.

Large fish-hooks like those found in Great Yarmouth were probably used for catching species other than gadids, for example, spurdog and other sharks, conger eel and halibut. Thornback ray, which is particularly frequent in English and Belgian assemblages, was probably also caught on hooks (a line sinker was found at Raversijde (B)). Brinkhuizen (1989a) mentioned that all marine species represented at Velsen I (NL, 1st century AD) are demersal (bottom-living) and that sea-fishing was conducted using lines.

FISHING WITH WEIRS

Very large catches may be obtained using weirs. Several complexes are known from England, for example from Colwick on the River Trent (9th and 11th-13th centuries AD) (Losco-Bradley & Salisbury, 1979; Salisbury, 1988). Weirs placed in rivers may catch large numbers of migratory species such as eel and salmon. It seems probable that the large numbers of eels caught in York (GB, 8th-9th centuries AD) are due to weirs of a kind.

Weirs placed on tidal coasts may be used for catching inshore species such as flatfish (plaice/flounder/dab) but also eel, salmonids and many others. The most abundant fishes found at Southampton (eel, flounder, European seabass and mullet; Bourdillon & Coy, 1980) were hypothesized by the authors to have been caught in intertidal traps or kiddles.

OTHER METHODS

Brinkhuizen (1989a) thought that the small cyprinids from Velsen 1 (NL, 1st century AD) indicate freshwater fishing using traps or nets. Remains of wickerwork fishtraps are known from Dorestad (NL), and an eel-trap from Ename (B).

Fishing seasons

Knowledge of fish biology may indicate the time of year at which fishing took place. Certain species, known as seasonal fish, occur in local waters exclusively in certain seasons and therefore reveal directly the fishing season. Garfish is a typical seasonal fish which has been found at sites in all the Baltic and North Sea countries studied except Estonia and Poland; it indicates fishing

during the summer half of the year. Atlantic mackerel only occurs in coastal waters during the summer half of the year but may be caught in the North Sea all the year round. Like garfish it is represented in material from all countries except Estonia and Poland. Other species which indicate summer fishing at coastal sites include Atlantic horsemackerel and European seabass.

Herring fishing from Great Yarmouth (GB) and in the Øresund region (DK and S) took place during the autumn, in connection with the herring migration.

In general, there are several indications that fishing took place in the summer half of the year. It is much more difficult to find signs of winter fishing. In England, however, small cod and haddock are assumed to have been caught during the winter, when they come closer to the coast. Although evidence for winter fishing is sparse, there is no reason to assume that fishing did not take place at this time of the year, both in the sea and in fresh water.

Trade in the Baltic and North Sea regions: how it can be indicated by fish bone assemblages

Fish bone assemblages indicate trade if they contain species which could not have been caught locally, for example marine species at inland sites, or exotic species. Over- or under-representation of certain skeletal elements may reveal fish processing characteristic of the fish trade, for example stockfish or gill-less herrings. Also, a limited size range of individuals in a bone assemblage may be indicative of trade, locally caught fish ussually exhibit a large size variation.

Indications of fish trade before AD 800

In Sweden, the Eketorp material from 5th-8th centuries AD (Hallström, 1979) contains bones of ling and vertebrae of large cod which have possibly been imported, since these are both rare in the Baltic Sea. In the Netherlands, bones of chub mackerel were found in material from the Roman settlements at Velsen and Nijmegen, 1st century AD, and at the latter site a single vertebra of barracuda appeared as well. Some of these bones have been interpreted as deriving from salted, imported fish, but other chub mackerel bones are possibly remnants of fish sauce imported from the south. Remains of fish sauce have also been found at two Roman sites in Belgium (Tongeren and Braives). As time went by, local fish sauce industries based on local raw materials arose (Bateman & Locker, 1982; Jones, 1988a; Van Neer & Ervynck, 1994b; Van Neer & Lentacker, 1994; Dobney *et al.*, 1996).

Danish, Estonian, Polish, German, English and Norwegian fish bone assemblages from this period provide no indications of trade.

Fish trade at major Viking and contemporaneous trading centres

Ribe on the Danish Wadden sea coast is known as an important Danish Viking Age trading centre and has yielded fish bone material dated to AD 700-850. All species in the Ribe Iron-Viking Age material could have been caught in the river, Ribe Å, or in the sea off Ribe. Although Ribe seems to have been an important trading centre, trade in fish is not suggested by the bone material.

The great importance of local fishing also characterizes the other major trading centres of this epoch, such as Sebbersund (DK, 8th-10th centuries AD), Birka (S, 10th century AD, Ericson *et al.*, 1988), Haithabu (D, 9th-11th centuries AD, Lepiksaar & Heinrich, 1977), Dorestad (NL, 8th-9th centuries AD) and York (GB, 8th-11th centuries AD).

In addition to local fishing there are some indications of limited import, perhaps in the form of travellers' supplies, to some of the centres. Thus, a small number of bones of ling, saithe and halibut were found at Haithabu. These species could not have been caught locally but are thought to represent provisions carried by travellers. The marine element in the York assemblages (Fishergate, Coppergate) is insignificant and may also represent travellers' supplies or minor import for sale. In the Dorestad material, however, there are a modest number of bones from gadids, plaice/flounder/dab and herring; exactly the fish most well suited for preservation and transport.

In conclusion, the fish remains from the trading centres active at the end of the first millienium AD do not reflect fish trade, with the possible exception of Dorestad.

Subsequent to the great trading centres mentioned above, trade in fish did gain very much in importance. Within the study area, the fish most suited for trade are gadids, herring and flatfish. These three groups will therefore be discussed individually, and a few words will then be added on trade with other species.

Trade in haddock, cod and other gadids

The clearest example of a gadid species whose representation in the subfossil assemblages changes significantly with time is the haddock. The earliest finds of haddock are from sites on or near the North Sea coast. In Denmark, there is a single haddock bone from Smedegaard (4th century BC - 2nd century AD, Enghoff, 1999), and there are several haddock bones from Ribe (8th-9th centuries) and Aggersborg (8th-10th centuries, Rosenlund, 1976). Further south on the North Sea coast, haddock occurs at Elisenhof (D) (8-13th centuries, most bones from the oldest phase). In the Netherlands haddock bones occur already at the Roman sites (1st century AD) on the coast. One must assume that the appearance of haddock at those sites where it could have been caught locally is determined by the development of fishing techniques.

Haddock appears in inland assemblages with some delay and gradually gains in importance. At Selsø-Vestby (DK, Enghoff, 1996), for example, haddock is absent from the 8th-10th century phases but appears in the 10th-11th centuries. From this time onwards, haddock is present in the majority of Danish assemblages, certainly as a result of trade, and its importance increases throughout the Middle Ages. Haithabu-Schleswig (D, Heinrich, 1983, 1987) provides another example of the delay in the appearance of haddock at inland sites. Haddock is absent altogether from the Haithabu material (9th-11th centuries) but at the succeeding settlement of Schleswig, the importance of haddock increases through the 11th-12th, 13th-14th and 15th-16th century phases. It seems, however, that trade in haddock did not extend beyond Schleswig: this species has not been found at any other German Baltic sites and is absent altogether from Polish and Estonian assemblages. On the other hand, haddock was imported in the north to the sites of Eketorp (11th-14th centuries) and Uppsala (13th-17th centuries) on the Swedish Baltic coast (Jonsson, 1986).

The above-mentioned delay in the appearance of haddock inland is also obvious in the North Sea region. For instance, haddock makes its appearance at Duisburg (D), more than 200 km from the sea, in the 13th century, and at Namur (B), far inland in Belgium, in the 14th-15th centuries, although it occurs generally in other Belgian material from the 12th century onwards.

In England, the increasing importance of haddock is seen, for instance, in York, Fishergate (GB) where the proportion of haddock bones in the assemblages increases from 0.05% of the identified bones in the 8th-9th centuries to 0.4% in the 11th-12th centuries AD, 4.2% in the 12th-16th centuries and 15% in the 16th century (O'Connor, 1991). Similarly in Newcastle (GB); 6% in 13th century, 8.1% in 14-15th centuries and 14.8% in 15-16th centuries (Nicholson, 1989).

Haddock is just one among many gadids which have been subject to trade. The others are cod, ling, saithe, pollack, torsk and perhaps whiting, as well as hake, a close relative of the gadids proper. For export purposes, these species were probably dried and/or salted. There were various methods of salting and drying but usually the product, stockfish, can be traced by a biased representation of the skeletal elements. Heinrich (1986, 1992) was of the opinion that remains of gadids from Medieval sites in northern Central Europe can, to a large extent, be regarded as evidence of trade with stockfish. Especially the west coast of Norway was an important source of stockfish. Western German merchants traded with Norway, and from the 13th century AD onward the Hanseatic League was the main trading company. After the introduction of Christianity, stockfish became very important as food during the fast (Heinrich, 1986, 1987). The gadid group as a whole appears first in material from coastal sites. Cod is mostly found earlier than haddock, because cod goes closer to the coast and is therefore easier to catch.

In a country like Denmark where any place is close to the sea, trade with marine fish is difficult to document. Accordingly, there is no evidence whatsoever of fish trade in Denmark prior to the Middle Ages when the import of gadids, among others, to monasteries and castles seems to have taken place.

In Sweden, the import of large cod and ling to Eketorp may have taken place as early as the 5th-8th centuries AD. In addition, large cod seem to have been imported to Sigtuna in the 12th century (Hårding, 1990), Uppsala in the 13th-14th centuries (Jonsson, 1986), Borganäs in the 14th-15th centuries (Sten, 1988) and Skara in the 13th-17th centuries (Lepiksaar, 1976). Hårding (1990) and Jonsson (1986) thought that the large cod may have come from the Atlantic Ocean, having been imported via Norway. The gadids from Skara were probably imported from Gamla Lödose on the Swedish North Sea (Kattegat) coast where bones from the same gadid species have been found. Fishing

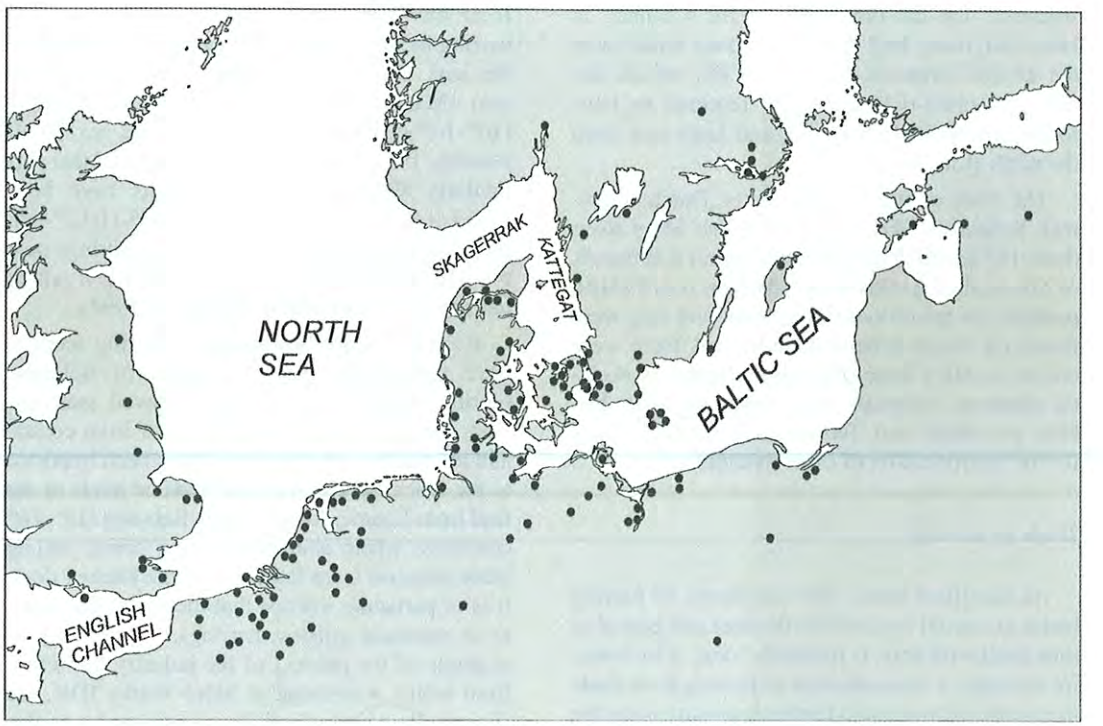

FIGURE 8

Map of the Baltic and North Sea region of Europe, showing the location of the reviewed sites in Enghoff (1999) and the present work.

from Gamla Lödöse, in turn, was probably local, as hake, ling and saithe could all have been caught off the coast at this site (*contra* Lepiksaar, 1965).

Small cod could have been caught in the Baltic Sea, whereas large cod in Baltic assemblages must be regarded as having been imported. For example, large cod seem to have been imported to Schleswig (D, 11th-14th centuries, Heinrich, 1987). Cod has also been imported to Lübeck (D, 12th-16th centuries, Paul, 1980; Pudek, 1980), and even to far-inland Freyenstein (D, 13th century, Benecke, 1989). For Germany in general, cod seems not to have been popular at Slavonic sites from where its bones are almost completely absent (Benecke, 1983; Heinrich, 1986, 1987). The situation in Poland apparently also reflects this cultural difference in fish taste: Among the Polish inland sites, only the Teutonic castle in Mała seems to have imported cod. Cod were also imported to the Medieval town of Tartu in Estonia in the 14th-16th centuries.

Gadids caught off the North Sea coast reached Hitzacker (D, von den Driesch, 1982) in the 12-16th centuries, and Duisburg (D) in the 10-14th centuries. Dutch and Belgian assemblages are generally rich in marine fish, including gadids, but it is difficult to determine when the importing of gadids commenced. In the Netherlands, gadids are present already at the trading centre of Dorestad, 8th-9th centuries, and bones of cod and ling from Leeuwarden (11th-14th centuries) seem to be the remains of stockfish. In Belgium, import of cod appears to have been going on at least since the 12th century.

In England, gadids made up only a very small part of the Viking Age material from York, but later material generally contains many gadid bones. The cod could have been caught off the English coast, as was the case at sites like King's Lynn and Great Yarmouth. The latter seems to have been the source of gadids and other marine fish imported to the inland town of Norwich. Remains of ling found in English assemblages (mostly 13th century) might represent imported fish. At Little Pickle (GB) not only ling, but also cod, pollack and saithe seem to have arrived as

stockfish. On the other side of the Channel, in Heist (B), many ling bones have been found from the 14-16th centuries. Even Oslo (N), which lies close to gadid-rich waters, is reported to have received imported dried ling and large cod from the north (Lie, 1988).

The finds of fish remains in the Dutch shipwreck Scheurrak SO1 and the English Mary Rose (both 16th century) provide direct proof that barrels of dried/salted gadids were taken on board ships, probably as provisions. Cod, torsk and ling were found on board Scheurrak SO1, and there were cod in the Mary Rose. The representation of skeletal elements indicates how these stockfish had been processed and, furthermore, provides clues for the interpretation of other assemblages.

Trade in herring

As described above, the occurrence of herring bones at coastal sites within the area and period of time dealt with here, is markedly local. It includes, for example, a concentration of herring bone finds in eastern Denmark and further eastward along the Baltic Sea coast. In particular, the abundance of herring bones at sites in the Øresund region (DK and S) is overwhelming, corroborating the historical accounts of an incredible Medieval "herring adventure" in this area. Special markets (the most famous of which was in Skanör, southwesternmost Sweden) arose with the purpose of trading herring freshly caught in the Øresund and then salted in barrels (Eriksson, 1980). A most interesting find relating to the herring industry has been made at Selsø-Vestby (DK) close to the Øresund region (13th-14th century). This is the first indication whatsoever of a technique involving the removal of the gills in order to increase the quality and durability of the preserved fish for export (Enghoff, 1996). Until now, the invention of this technique has been ascribed to a 14th century Dutchman named Beukelszoon van Biervliet (Seeman, 1986).

The importing of herring to the Swedish interior is not suggested by the bone evidence; not a single herring bone has been found at Swedish inland sites. In contrast, herring appear to have been extensively imported to inland Baltic Germany and Poland. Herring bones have been found at Menzlin (D, 9th-10th centuries, Benecke, 1987), Lieps (D, 10th-13th centuries, Benecke, 1984) and Freyenstein (D, 13th century, Benecke, 1989) far from the Baltic coast. Polish inland sites with herring include Poznan (12th century, 240 km from the sea), Santok (13th century, 160 km from the sea) (Makowiecki pers. comm.), and Wrocław (10th-14th centuries, 400 km from the sea, Kozikowska, 1974). It may not be coincidental that particularly abundant herring remains have been found at Kolobrzeg-Budsistowa (8/9th-11/12th centuries) on the Polish coast. The salty springs near this site would have been very useful when salting herring for export inland (Rulewicz, 1994).

Even the North Sea stocks of herring seem to have formed the basis for trade. In Belgium, herring is generally present in sieved materials from the 12th century onwards, both from coastal and inland sites. Herring must have been imported to the latter. Special mention must be made of the find from Ename, Abbey of San Salvator (15th-16th centuries) where abundant herring bones, among other remains, were found under the kitchen floor. It is of particular interest that these remains appear to represent gill-less herrings. This is thus an example of the product of the industry the refuse from which was found at Selsø-Vestby (DK, see above). Remains of gill-less herrings have also been found at a Dutch 17th century whaling station on the island of Spitsbergen in the Arctic Ocean (Seeman, 1986).

Herring bones occur commonly at English sites, to some of which the fish must have been imported. Examples are the Gilbertine Priory in York (12th-16th centuries), St. Gregory's Priory in Canterbury (12th-16th centuries AD) and Westminster Abbey in London (11th-13th centuries).

Van Neer & Pieters (1997) and Benecke (1982) argued that the narrow size range seen in some assemblages of herring bones from inland size can be taken as evidence that the herring had been processed and imported.

Trade in flatfish

Flatfish, in particular the plaice/flounder/dab-group, are well suited for drying and salting, and hence for trade. Accordingly, plaice/flounder/dab is represented at Danish monasteries such as Odense Sortebrødrekloster (13th-16th centuries, Rosenlund, 1976) and Øm Kloster (15th-16th centuries, Rosenlund, 1984) to where they must have been imported. As we saw with the herring, Sweden is different in this respect: there is not a single bone of plaice/flounder/dab from a Swedish inland site, and

thus no indication of trade in flatfish. Both plaice and flounder had reached the inland site of Dorestad (NL) by the 15th century, and plaice had reached Utrecht (NL) by the same time. Belgian assemblages generally contain plaice/flounder/dab from the 12th century onwards, an exception being Namur, which lies far inland.

The Belgian fishing village of Raversijde has produced a most interesting find relating to the 15th century fish industry: Remains of the head and tails of plaice were found together with bivalve shells interpreted as the fish's stomach contents. Maybe Raversijde was a source of flatfish exported to the Belgian interior.

Trade with flatfish also took place in England: From coastal Great Yarmouth (10th-13th centuries) to contemporaneous Norwich, and from the coast to high-status sites like the priory of the Gilbertine order in York and Westminster Abbey in London.

Trade in other fish species

Trade with pike seems to have played an important role in Sweden where this species appears to have been of great importance at Birka (10th century, Ericson *et al.*, 1988), Borganäs (14th-15th centuries, Sten, 1988), Uppsala (13th-17th centuries, Jonsson, 1986) and Stockholm (14th-15th centuries, Vretemark, 1982). Pike bones from the latter three sites have been interpreted, on the basis of butchering traces, as remains of dried pike, probably imported from northern Sweden (Jonsson, 1986). Finds of pike represented solely by the head and shoulder bones have been made at the Polish sites of Tolkmicko (7th-5th centuries BC, Filuk, 1968) and Szczecin (9th-11th centuries AD, Chelkowski, 1959), and at German Schleswig (11th-14th centuries AD). These finds may also represent the remains of dried pikes.

Many other species have been subject to trade. For instance, the fish bone evidence reflects intensive fishing for sturgeon which was regarded as a precious fish, often reserved for the upper class. Sturgeon is accordingly seen in assemblages from monasteries and similar sites. Salmon, trout and thornback ray seem to have been similarly highly esteemed, the latter possibly only in the Nordic countries.

A particularly illustrative example of how varied the import of marine fish to an inland site could be, is provided by the material from Ename, Abbey of St. Salvator (B, 15th-16th centuries). The diet of the late Medieval inhabitants of this abbey included the following marine fish: thornback ray, herring, cod, whiting, haddock, turbot, plaice, flounder and common sole.

CONCLUDING REMARKS

Just as for the Baltic fishing (Enghoff, 1999), a chronological development in fishing is indicated by the North Sea fish bone assemblages. Furthermore, a joint consideration of both areas reveals some general tendencies. Starting with fishing for local consumption, a stage was reached, through the development of better methods for catching, processing and preserving fish, where fish could be exported to places where a demand had arisen due either to local over-fishing, pollution, or perhaps the Christian rules for food consumption during the fast (Lent).

A glance at the maps showing the sites dealt with in this review reveals that they are all located either on the coast or on a major watercourse (a river or the like). There can thus be no doubt that ships played a major role in man-fish relationships, either as fishing vessels or as a means of transportation.

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Catalogue of Subfossil Fish Remains from Poland

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ABSTRACT: This paper presents a catalogue of late glacial and Holocene assemblages of fish remains from the territory of Poland. A total of 167 assemblages have been recorded. The catalogue provides a description of the identified fish species and their frequencies. The database exhibits geographical and temporal biases in relation to the distribution of fish bone assemblages

KEY WORDS: FISH, LATE GLACIAL, HOLOGENE, POLAND

RESUMEN: Este trabajo presenta un catálogo de conjuntos ictioarqueológicos polacos del Pleistoceno tardío y del Holoceno. En conjunto se registran 167 yacimientos. El catálogo proporciona una descripción de las especies de peces identificados y de sus frecuencias. La base de datos evidencia sesgos geográficos y temporales relativos a la distribución de las muestras ictiofaunísticas

PALABRAS CLAVE: PECES, PLEISTOCENO FINAL, HOLOCENO, POLONIA

INTRODUCTION

Despite the fact that studies on animal remains from archaeologicalsites in Poland have a long tradition, research on bones and scales from fish remained fairly restricted for a long time for several reasons. Publications of the pre-War period only occasionally mention the presence of fish remains and present data concerning their identification (e.g. Lubicz-Niezabitowski 1929, 1936, 1938). In the 50s and 60s Z. Chełkowski carried out systematic researchłkowski carried out systematic research on large collections of fish remains from Neolithic and Medieval sites along the Baltic coast (e.g. Chełkowski 1959, 1960 a, b, 1966). His work was continued by J. Kaj, J. Filuk and M. Iwaszkiewicz (Kaj 1950, 1953, 1960; Filuk 1966a, 1968, 1993; Iwaszkiewicz 1964, 1969, 1975 a, b, 1985, 1993). During the last 10 years many fish bones assemblages from various parts of Poland and from different periods have been studied by the author. Unfortunately, most of these materials remained unpublished so far. The publication of this catalogue is intended to serve as a help to those, archaeolozoologists, zoologists as well as archaeologists and others, who take an interest in the subfossil ichthyofauna from the Polish territory known so far.

THE CATALOGUE

The catalogue presented here includes as far as possible all known collections of fish remains from archaeological sites in Poland. Besides published materials all unpublished collections studied by the author have been taken into consideration. The catalogue is divided into two sections.

The first part (Table 1) gives a description of the assemblages which are arranged according to periods. For every single assemblage the following information is presented: number of site, name of the locality, geographical coordinates, list of species with frequencies and references. In the second part of this catalogue (Table 2) the species are listed in systematic order and the assemblages are identified by the number code givento each one of them in Table 1.

No	Site	Fish species	References
		Late Pleistocene - Bölling	
1.	Mirkowice 33 *(N52,48/E17,24)*	*Salmonidae 7,Cyprinidae 3, Esox lucius 112, Perca fluviatilis 48*	N
		Pre-Boreal – Boreal/Atlantic – Mesolithic	
2.	Dudka 1 *(N53,59/E22,00)*	*Cyprinidae 63, Silurus glanis 8, Esox lucius 79, Perca fluviatilis 23*	N, Gumiński 1995
		Preboreal – Mesolithic	
3.	Miłuki 4 *(N53,53/E22,21)*	*Esox lucius 8, Perca fluviatilis 8*	N
4.	Tłokowo 2 *(N54,00/E20,45)*	*Cyprinidae 13, Rutilus rutilus 17, Esox lucius 1,Percidae 1, Perca fluviatilis 5*	N
		Boreal – Mesolithic	
5.	Tłokowo 2 *(N54,00/E20,45)*	*Cyprinidae 46, Carassius carassius 2, Tinca tinca 51, Leuciscus cephalus 1, Rutilus rutilus 1, Esox lucius 453, Percidae 4, Perca fluviatilis 16, Stizostedion lucioperca 1*	N
		Boreal/Atlantic – Mesolithic	
6.	Mszano 14 *(N53,15/E19,20)*	*Cyprinidae 49, Rutilus rutilus 4, Esox lucius 11, Percidae 1, Perca fluviatilis 5, Stizostedion lucioperca 4*	N
7.	Pobiel 10 *(N51,33/E16,42)*	*Esox lucius+, Tinca tinca+, Leuciscus idus+*	Bagniewski 1990
		Atlantic - Late Mesolithic	
8.	Dudka 1 *(N53,59/E22,00)*	*Cyprinidae 325, Tinca tinca 15, Rutilus rutilus 14, Silurus glanis 94, Esox lucius 274, Percidae 1 Perca fluviatilis 208*	N, Gumiński 1995
		Atlantic – Early Neolithic/Middle Neolithic	
9.	Bożejewice, 22/23 – GAZ 381 *(N52,43/E18,14)*	*Cyprinidae 69, Rutilus rutilus 1, Esox lucius 36*	N
10.	Brześć Kujawski 3 *(N52,36/E18,35)*	*Cyprinidae 1609, Abramis brama 10, Abramis ballerus 2, Leuciscus idus 7, Aspius aspius 26, Rutilus rutilus 140, Scardinius erythrophthalmus 9, Carassius carassius 9, Tinca tinca 305, Esox lucius 254, Perca fluviatilis 113*	N
11.	Dąbki 9 *(N54,23/E16,19)*	*Acipenser sturio+, Anguilla anguilla 4, Salmonidae 9 (Salmo salar/Salmo trutta), Cyprinidae 296, Tinca tinca 5, Carassius carassius+, Leuciscus idus+, Aspius aspius+, Vimba vimba+, Rutilus rutilus 4, Abramis brama 50, Silurus glanis 25, Esox lucius 250, Perca fluviatilis 103, Stizostedion lucioperca 104*	Iwaszkiewicz 1985, Ilkiewicz 1989, N
12.	Łagiewniki 5 *(N52,04/E18,02)*	*Esox lucius 7 (1 individual)*	Sobociński 1981
13.	Osłonki 1 *(N52,36/E18,54)*	*Cyprinidae 384, Carassius carassius 1, Tinca tinca 16, Rutilus rutilus 3, Scardinius erythrophthalmus 8, Abramis brama 1, Aspius aspius 8, Esox lucius 93, Perca fluviatilis 1*	N
14.	Siniarzewo 1 – GAZ *(N52,44/E18,41)*	*Cyprinidae 4, Aspius aspius 1*	N
15.	Stolno 2 *(N53,19/E18,31)*	*Cyprinidae 137, Rutilus rutilus 3, Leuciscus cephalus 2, Abramis ballerus 1, Abramis brama 1, Esox lucius 114, Percidae 1*	Makowiecki 1987, N
16.	Dudka 1 *(N53,59/E22,00)*	*Cyprinidae 286, Tinca tinca 16, Rutilus rutilus 15, Abramis brama 14, Silurus glanis 81, Esox lucius 395, Perca fluviatilis 66*	N, Gumiński 1995
17.	Żegotki 3 – GAZ *(N52,42/E18,13)*	*Cyprinidae 2, Rutilus rutilus 1*	N
18.	Żegotki 5 – GAZ 376 *(N52,42/E18,13)*	*Cyprinidae 240, Tinca tinca 1, Rutilus rutilus 3, Scardinius erythrophthalmus 1, Esox lucius 27, Perca fluviatilis 1*	N
		Atlantic/Sub-Boreal – Middle Neolithic/Late Neolithic	
19.	Dudka 1 *(N53,59/E22,00)*	*Cyprinidae 3693, Carassius carassius 1, Tinca tinca 201, Leuciscus idus 1, Rutilus rutilus 165, Scardinius*	N,

TABLE 1

Catalogue of fish remains from Poland. Sites arranged to climatic and archaeological periods.

No	Site	Fish species	References
		erythrophthalmus 2, Abramis brama 21, Silurus glanis 1451, Esox lucius 3949, Percidae 3, Perca fluviatilis 2774	
20.	Mszano 14 *(N53,15/E19,20)*	*Anguilla anguilla 1, Cyprinidae, 47, Tinca tinca 3, Rutilus rutilus 1, Silurus glanis 1, Esox lucius 17, Percidae 1, Perca fluviatilis 8, Stizostedion lucioperca 10*	N
21.	Sandomierz - Żmigród *(N50,41/E21,45)*	*Rutilus rutilus+, Scardinius erythrophthalmus+, Abramis brama+, Silurus glanis+*	Iwaszkiewicz 1993
		Sub-Boreal – Middle Neolithic/Late Neolithic	
22.	Dudka 1 *(N53,59/E22,00)*	*Anguilla anguilla 1, Cyprinidae 958, Tinca tinca 57, Rutilus rutilus 40, Abramis brama 3, Silurus glanis 219, Esox lucius 1147, Percidae 1, Perca fluviatilis 260*	N,
23.	Krusza Zamkowa 3 *(N52,44/E18,14)*	*Esox lucius 2*	Czerniak 1980
24.	Ustowo 1 *(N53,25/E14,35)*	*Acipenser sturio 2, Tinca tinca 127, Leuciscus idus 2, Rutilus rutilus 37, Scardinius erythrophthalmus 1, Abramis brama 166, Aspius aspius 5, Silurus glanis 33, Esox lucius 63, Perca fluviatilis 2, Stizostedion lucioperca 107*	Chełkowski 1960a
25.	Dąbrowa Biskupia 21 *(N52,47/E18,33)*	*Cyprinidae 4, Tinca tinca 3, Abramis brama 1*	N
26.	Kaczkowo *(N52,48/E17,44)*	*Esox lucius 1*	Wiślański 1966
27.	Księżnice Wielkie *(N50,10/E20,34)*	*Aspius aspius 1*	Sych 1964
		Sub-Boreal – Late Neolithic	
28.	Nosocice *(N51,40/E16,06)*	*Esox lucius+*	Sobociński 1961
29.	Opatowice 3 *(N52,37/E18,30)*	*Cyprinidae 1*	N
30.	Opatowice 36 *(N52,37/E18,30)*	*Esox lucius 4*	N
31.	Chwalim 1 *(N52,04/E15,51)*	*Cyprinidae 60, Abramis brama* (scales), *Silurus galnis 25, Esox lucius 14, Percidae 3*	Gautier & Kobusiewicz 1992; Gautier 1993
32.	Dudka 1 *(N53,59/E22,00)*	*Cyprinidae 109, Tinca tinca 6, Rutilus rutilus 8, Abramis brama 1, Silurus glanis 16, Esox lucius 303, Perca fluviatilis 49*	N
33.	Rzucewo 1 *(N54,42/E18,28)*	*Gadus morhua 4952, Clupeidae 29, Clupea harengus 269, Pleuronectidae 431, Platichthys flesus 13, Acipenser sturio 1, Anguilla anguilla 437, Cyprinidae 68, Rutilus rutilus 14, Abramis brama 14, Esox lucius 621, Perca fluviatilis 2294, Stizostedion lucioperca+, Gasterosteus aculeatus+, Noemacheilus barbatulus+*	Makowiecki & Neer 1996
34.	Mszano 14 *(N53,15/E19,20)*	*Cyprinidae 1, Esox lucius 2, Perca fluviatilis 1*	N
		Sub-Boreal – Late Neolithic/ Bronze Age	
35.	Samborowo 10 *(N53,41/E19,49)*	*Cyprinidae 31, Silurus glanis 1, Esox lucius 9, Perca fluviatilis 5, Stizostedion lucioperca 1*	N
		Sub-Boreal –Bronze Age	
36.	Biskupin 2a *(N52,46/E17,44)*	*Cyprinidae 44 (Rutilus rutilus+, Abramis brama+, Blicca björkna+, Alburnus alburnus), Esox lucius 41, Perca fluviatilis 63*	Makowiecki & Makowiecka 1998
37.	Rybiny 17 *(N52,29/E18,47)*	*Cyprinidae 4, Esox lucius 4, Perca fluviatilis 1*	N
38.	Laski *(N51,12/E18,02)*	*Esox lucius 14*	Iwaszkiewicz 1988
39.	Łagiewniki 5/7 *(N52,04/E18,02)*	*Rutilus rutilus+, Perca fluviatilis+*	Szamałek 1987
		Sub-Atlantic – Late Bronze Age – La Tene Period	
40.	Kruszwica 2-4 *(N52,41/E18,18)*	*Rutilus rutilus+, Scardinius erythrophthalmus+*	Szamałek 1987

TABLE 1 (cont.)

Catalogue of fish remains from Poland. Sites arranged to climatic and archaeological periods.

No	Site	Fish species	References
41.	Łagiewniki 5/7 *(N52,04/E18,02)*	*Rutilus rutilus+, Abramis brama+*	Szamałek 1987
42.	Biskupin 4 *(N52,46/E17,44)*	*Rutilus rutilus+, Abramis brama+, Blicca björkna+, Silurus glanis+, Esox lucius+, Perca fluviatilis+*	Lubicz-Niezabitowski 1936, 1938, 1948; Kaj 1950
43.	Bnin 2a *(N52,14/E17,06)*	*Rutilus rutilus+, Perca fluviatilis+*	Iwaszkiewicz 1979
44.	Bnin 2b *(N52,14/E17,06)*	*Carassius carassius+, Rutilus rutilus+, Abramis brama+, Esox lucius+, Parca fluviatilis+, Stizostedion lucioperca+*	Iwaszkiewicz 1979
45.	Łęcze 1 *(N54,17/E19,28)*	*Acipenser sturio 1, Salmo trutta 3, Rutilus rutilus 4, Abramis brama 34, Blicca björkna1, Pelecus cultratus 2, Stizostedion lucioperca 1*	Filuk 1966a
46.	Objezierze 1 *(N52,36/E16,46)*	*Tinca tinca+, Abramis brama+, Esox lucius+*	Iwaszkiewicz 1964
47.	Szczecin (Grodzka) *(N53,25/E14,35)*	*Acipenser sturio 3*	Chełkowski 1966
48.	Szczecin (Wzgórze Zamkowe) *(N53,25/E14,35)*	*Acipenser sturio 1, Rutilus rutilus 1, Abramis brama 9, Silurus glanis 2, Esox lucius 1, Stizostedion lucioperca 2*	Chełkowski 1965a
49.	Święty Wojciech 10 – GAZ 57) *(N52,27/E 15,32)*	*Cyprinidae 1*	Makowiecki 1998c
50.	Tolkmicko 1 *(N54,20/E19,31)*	*Acipenser sturio 36, Salmo trutta 1, Carassius carassius 1, Leuciscus idus 1, Rutilus rutilus 215, Vimba vimba 1, Abramis brama 2757, Blicca björkna 92, Pelecus cultratus 112, Aspius aspius 11, Silurus glanis 5, Esox lucius 45, Perca fluviatilis 55, Stizostedion lucioperca 393, Lota lota 2*	Filuk 1966b, 1968
51.	Ustowo 1 *(N53,25/E14,35)*	*Abramis brama 1, Stizostedion lucioperca 4*	Chełkowski 1960a
52.	Żubronajć *(N54,07/E23,10)*	*Cyprinidae 394, Tinca tinca 16, Rutilus rutilus 106, Scardinius erythrophthalmus 18, Leuciscus cephalus 3, Leuciscus leuciscus 2, Abramis brama 28, Silurus glanis 1, Esox lucius 102, Perca fluviatilis 27*	N
53.	Żółwin 29 – GAZ 63 *(N52,28/E15,39)*	*Cyprinidae 1, Esox lucius 1*	Makowiecki 1998d
		Sub-Atlantic – Roman Influences Period	
54.	Jaworze *(N53,18/E19,02)*	*Salmo trutta 1(Salmo trutta trutta* m *fario*	N
55.	Polanowice 4 *(N52,39/E18,17)*	*Rutilus rutilus+, Abramis brama+, Esox lucius+*	Dieduszycka 1982
56.	Paprotki Kolonia 41 *(N53,03/E20,45)*	*Cyprinidae 84, Abramis brama 3, Esox lucius 6, Percidae 3, Perca fluviatilis 58*	N
57.	Wyszembork 5 *(N53,56/E21,22)*	*Cyprinidae 28, Abramis brama 1, Esox lucius 15, Perca fluviatilis 1*	N
58.	Wyszembork (island of Salent Lake) *(N53,56/E21,22)*	*Rutilus rutilus 36, Scardinius erythrophthalmus 7, Abramis brama 268, , Blicca björkna 1, Alburnus alburnus 21, Silurus glanis 2, Esox lucius 58, Perca fluviatilis 13*	Filuk 1993
		Sub-Atlantic – Early Middle Ages (400 – 1250/1350)	
59.	Biskupin 2a *(N52,46/E17,44)*	*Rutilus rutilus+, Scardinius erythrophthalmus+, Abramis brama+, Silurus glanis+, Esox lucius+, Perca fluviatilis+*	Mackiewicz 1989
60.	Biskupin 4 *(N52,46/E17,44)*	*Carassius carassius+, Tinca tinca+, Rutilus rutilus+, Scardinius erythrophthalmus+, Abramis brama+, , Blicca björkna+, Silurus glanis+, Esox lucius+, Perca fluviatilis+*	Lubicz - Niezabitowski 1948; Kaj 1950
61.	Biskupin 6 *(N52,46/E17,44)*	*Silurus glanis+*	Mackiewicz 1989
62.	Błonie 1 *(N52,12/E20,37)*	*Acipenser sturio 8, Barbus barbus* (scales), *Rutilus rutilus 11, Abramis brama 10, Leuciscus idus* (scales), *Esox lucius 2, Perca fluviatilis 12*	Kaj 1953
63.	Bnin 2a *(N52,14/E17,06)*	*Tinca tinca+, Rutilus rutilus+, Scardinius erythrophthalmus+, Abramis brama+, Blicca björkna+, Silurus glanis+, Esox lucius+, Perca fluviatilis+, Stizostedion lucioperca+*	Iwaszkiewicz 1975a
64.	Bnin 2b	*Carassius carassius+, Tinca tinca+, Rutilus rutilus+, Scardinius*	Iwaszkiewicz 1975a

TABLE 1 (cont.)

Catalogue of fish remains from Poland. Sites arranged to climatic and archaeological periods.

No	Site	Fish species	References
	(N52,14/E17,06)	*erythrophthalmus+, Abramis brama+, Esox lucius+, Perca fluviatilis+*	
65.	Brodnica – Michałowo 1 *(N53,15/E19,24)*	*Cyprinidae 1, Tinca tinca 1, Abramis brama 1, Silurus glanis 2, Esox lucius 5, Perca fluviatilis 2, Stizostedion lucioperca 2*	N
66.	Bruszczewo 12 *(N52,02/E16,36)*	*Cyprinidae 6, Tinca tinca 1, Esox lucius 2, Percidae 1*	N
67.	Bydgoszcz 1 *(N53,09/E18,00)*	*Acipenser sturio 5, Salmonidae 3, Cyprinidae 3, Tinca tinca 1, Silurus glanis 2, Esox lucius 1*	N
68.	Bytom Odrzański 1 *(N 51,44/E 15,50)*	*Cyprinidae 4, Rutilus rutilus 1, Leuciscus idus 2, Leuciscus cephalus 2, Silurus glanis 6, Esox lucius 6*	N
69.	Charzykowy *(N 53,44/E 17,31)*	*Scardinius erythrophthalmus+, Abramis brama+, Esox lucius+, Perca fluviatilis+*	Iwaszkiewicz 1980
70.	Chmielno 1 *(N54,20/E 18,06)*	*Rutilus rutilus+, Abramis brama+, Esox lucius+, Perca fluviatilis+, Stizostedion lucioperca+*	Mackiewicz 1989
71.	Ciepłe 3 *(N 53,52/E 18,51)*	*Acipenser sturio+, Rutilus rutilus+, Abramis brama+, Silurus glanis+, Esox lucius+, Perca fluviatilis+, Stizostedion lucioperca+*	Mackiewicz 1989
72.	Czersk 1 *(N 52,05/E 21,02)*	*Acipenser sturio+, Barbus barbus+, Abramis brama+, Esox lucius+, Stizostedion lucioperca+*	Mackiewicz 1989
73.	Dąbrówka 1 *(N 52,22/E16,42)*	*Esox lucius 2*	Benecke 1986
74.	Drohiczyn 1, 2, 3 *(N 52,24/E 22,39)*	*Barbus barbus+, Vimba vimba+, Rutilus rutilus+, Abramis brama+, Blicca björkna+, Aspius aspius+, Esox lucius+, Perca fluviatilis+*	Iwaszkiewicz 1969
75.	Dziekanowice 22 *(N 52,31/E 17,23)*	*Clupea harengus 2, Acipenser sturio 5, Cyprinidae 7, Tinca tinca 2, Rutilus rutilus 1, Leuciscus idus 1, Esox lucius 9, Perca fluviatilis 2*	Makowiecki 1997, 1998b
76.	Fordon 1 *(N 53,09/E 18,11)*	*Acipenser sturio+*	Mackiewicz 1989
77.	Gdańsk (Olejarna 2) *(N 54,21/E 18,40)*	*Gadus morhua 20, Pleuronectidae 1, Acipenser sturio 682, Cyprinidae 20, Tinca tinca 9, Rutilus rutilus 1, Abramis brama 9, Aspius aspius 4, Leuciscus idus 1, Silurus glanis 9, Esox lucius 17, Percidae 1, Perca fluviatilis 2, Stizostedion lucioperca 32*	N
78.	Giecz 1 *(N52,19/E17,22)*	*Clupea harengus+, Acipenser sturio+, Salmonidae+, Carassius carasius+, Tinca tinca+, Rutilus rutilus+, Abramis brama+, Blicca björkna+, Silurus glanis+, Esox lucius+*	Mackiewicz 1989
79.	Gniezno – Piotrowo 40 *(N52,33/E17,36)*	*Acipenser sturio 14, Abramis brama 1, Silurus glanis 1, Esox lucius 2*	N
80.	Gniezno 13, 14, 15, 15c, 15d *(N52,33/E17,36)*	*Acipenser sturio 22, Salmo salar+, Cyprinidae 5, Aspius aspius+, Vimba vimba+, Carassius carassius+, Cyprinus carpio+, Alburnus alburnus+, Scardinis erythrophthalmus+, Tinca tinca 6, Rutilus rutilus 1, Abramis brama 13, Silurus glanis 5, Esox lucius 7, Percidae 1, Perca fluviatilis 2, Stizostedion lucioperca 2*	N, Mackiewicz 1989
81.	Gołańcz Pomorska 1 *(N54,05/E15,22)*	*Tinca tinca 1, Abramis brama 4, Esox lucius 1, Stizostedion lucioperca 2*	Chełkowski & Chełkowska 1964a
82.	Gorzędziej 1 *(N54,03/E18,49)*	*Acipenser sturio+, Rutilus rutilus+, Abramis brama+, Pelecus cultratus+, Perca fluviatilis+, Stizostedion lucioperca+*	Mackiewicz 1989
83.	Góra 1 (near Poznań) *(N52,27/E16,42)*	*Silurus glanis+, Esox lucius+*	Mackiewicz 1989
84.	Gronowo 2 *(N53,07/E18,48)*	*Cyprinidae 1, Tinca tinca 2, Esox lucius 5*	N
85.	Grotniki 6 *(N51,57/E16,21)*	*Silurus glanis 11*	N
86.	Grzybowo 1 *(N52,20/E17,38)*	*Clupea harengus 1, Acipenser sturio 15, Salmonidae 1, Cyprinidae 101, Tinca tinca 2, Abramis brama 1, Rutilus rutilus 11, Scardinius erythrophthalmus 1, Silurus glanis 1, Esox lucius 41, Percidae 5, Perca fluviatilis 29, Stizostedion lucioperca 2*	N

TABLE 1 (cont.)

Catalogue of fish remains from Poland. Sites arranged to climatic and archaeological periods.

No	Site	Fish species	References
87.	Gwieździn 1 *(N53,40/E17,22)*	*Carassius carasius+, Scardinius erythrophthalmus+, Abramis brama+, Silurus glanis+, Esox lucius+, Perca fluviatilis+*	Mackiewicz 1989
88.	Kałdus 3, 6 *(N53,20/E18,25)*	*Acipenser sturio+, Rutilus rutilus+, Scardinius erythrophthalmus+, Abramis brama+, Silurus glanis+, Esox lucius+, Perca fluviatilis+*	Mackiewicz 1989
89.	Kamień Pomorski *(53,58/E14,47)*	*Tinca tinca 4, Rutilus rutilus 3, Abramis brama 2, Blicca björkna 1, Vimba vimba 1, Esox lucius 3, Perca fluviatilis 2, Stizostedion lucioperca 20*	Chełkowski 1960b
90.	Kędrzyno 1 *(N54,04/E15,23)*	*Clupea harengus 2, Acipenser sturio 1, Salmonidae 20, Tinca tinca 41, Leuciscus idus 1, Leuciscus cephalus 4, Rutilus rutilus 20, Abramis brama 112, Blicca björkna 1, Esox lucius 58, Perca fluviatilis 252, Stizostedion lucioperca 33, Gymnocpehalus cernuus 2, Lota lota 3*	Chełkowski & Chełkowska 1964b
91.	Kędrzyno 3 *(N54,04/E15,23)*	*Tinca tinca 27, Rutilus rutilus 11, Abramis brama 19, Esox lucius 2, Perca fluviatilis 3, Stizostedion lucioperca 19, Lota lota 1*	Chełkowski & Chełkowska 1964a
92.	Kołobrzeg 1 *(N54,11/E15,35)*	*Gadus morhua 3, Clupea harengus 3235, Platichthys flesus 16, Acipenser sturio 60, Anguilla anguilla 1, Cottus* sp. *7, Salmo salar 3, Rutilus rutilus 32, Abramis brama 29, Vimba vimba 1, Esox lucius 18, Perca fluviatilis 7, Stizostedion lucioperca 6*	Leciejewicz 1985, 1991; Rulewicz 1994
93.	Krępsk 1 *(N53,43/E17,12)*	*Carassius carassius+, Rutilus rutilus+, Scardinius erythrophthalmus+, Abramis brama+, Esox lucius+, Perca fluviatilis+, Stizostedion lucioperca+*	Iwaszkiewicz 1980
94.	Kruszwica 2-4 *(N52,41/E18,18)*	*Clupea harengus+, Acipenser sturio+, Salmo salar+, Carassius carassius+, Tinca tinca+, Leuciscus idus+, Leuciscus cephalus+, Rutilus rutilus+, Scardinius erythrophthalmus+, Abramis brama+, Blicca björkna+, Silurus glanis+, Esox lucius+, Perca fluviatilis+, Stizostedion lucioperca+, Coregonus albula+*	Dzieduszycki & Kupczyk 1993
95.	Kruszwica 4 *(N52,41/E18,18)*	*Acipenser sturio+, Salmo salar+, Carassius carassius+, Tinca tinca+, Leuciscus idus+, Leuciscus cephalus+, Rutilus rutilus+, Scardinius erythrophthalmus+, Abramis brama+, Stizostedion lucioperca+, Coregonus albula+*	Mackiewicz 1989
96.	Ląd *(N52,13/E17,54)*	*Acipenser sturio 26, Cyprinidae 16, Tinca tinca 2, Leuciscus idus 6, Aspius aspius 1, Scardinius erythrophthalmus 5, Silurus glanis 11, Esox lucius 26, Perca fluviatilis 2, Stizostedion lucioperca 1, Lota lota 1*	N
97.	Lembarg 6 *(N53,21/E19,12)*	*Abramis brama 1, Silurus glanis 2, Esox lucius 1*	N
98.	Łącko 5 *(N52,52/E18,18)*	*Carassius carassius+, Tinca tinca+, Rutilus rutilus+, Scardinius erythrophthalmus+, Abramis brama+, Esox lucius+, Perca fluviatilis+, Stizostedion lucioperca+*	Iwaszkiewicz – manuscript
99.	Mietlica 1 *(N52,38/E18,26)*	*Salmo trutta+, Tinca tinca+, Abramis brama+, Silurus glanis+, Esox lucius+,*	Dzieduszycki & Kupczyk 1993
100.	Mietlica 2/3 *(N52,38/E18,26)*	*Cyprinidae 134,Tinca tinca 11, Abramis brama 2, Silurus glanis 3, Esox lucius 44, Percidae 2, Perca fluviatilis 14*	N
101.	Mietlica 3 *(N52,38/E18,26)*	*Silurus glanis 1, Stizostedion lucioperca 1, Blicca björkna 1*	Jernigan-Maloney & Sobociński 1983
102.	Młynek – Kczew 1 *(N54,23/E18,20)*	*Acipenser sturio 6, Esox lucius 1, Stizostedion lucioperca 2*	N
103.	Napole 1 *(N53,09/E18,59)*	*Acipenser sturio 3, Cyprinidae 1, Tinca tinca 3, Esox lucius 5*	N
104.	Napole 6 *(N53,09/E18,59)*	*Cyprinidae 3, Abramis brama 1, Tinca tinca 3, Esox lucius 9*	N
105.	Nowy Dworek 7 *(N52,20/E15,30)*	*Cyprinidae 14, Tinca tinca 5, Rutilus rutilus 3, Scardinius erythrophthalmus 4, Esox lucius 17, Perca fluviatilis 5*	N
106.	Objezierze 1 *(N52,36/E16,46)*	Rutilus rutilus+, Silurus glanis+, Esox lucius+	Iwaszkiewicz 1964
107.	Opole – Ostrówek	*Cyprinidae+, Abramis brama+, Esox lucius+, Perca fluviatilis+*	Mackiewicz 1989

TABLE 1 (cont.)

Catalogue of fish remains from Poland. Sites arranged to climatic and archaeological periods.

No	Site	Fish species	References
	(N50,40/E17,57)		
108.	Ostrów Lednicki 1 *(N52,32/E17,23)*	*Acipenser sturio 118, Salmonidae 1, Cyprinidae 23, Tinca tinca 16, Leuciscus idus 2, Leuciscus cephalus 1, Rutilus rutilus 1, Abramis brama 16, Aspius aspius 3, Silurus glanis 36, Esox lucius 35, Percidae 1,Perca fluviatilis 12, Stizostedion lucioperca 3*	Makowiecki 1993, 1997, 1999b
109.	Ostrów Lednicki 2 *(N52,32/E17,23)*	*Acipenser sturio 26, Tinca tinca 1, Silurus glanis 3, Esox lucius 4, Perca fluviatilis 4*	Makowiecki 1993, 1997, 1999
110.	Owidz 1 *(N53,58/E18,34)*	*Acipenser sturio+*	Mackiewicz 1989
111.	Pasym Ostrów – Okrągła Góra *(N53,39/E20,42)*	*Carassius carassius+, Tinca tinca+, Rutilus rutilus+, Scardinius erythrophthalmus+, Abramis brama+, Blicca björkna+, Alburnus alburnus+, Esox lucius+, Perca fluviatilis+, Stizostedion lucioperca+*	Odoj 1968
112.	Płock *(N52,33/E19,42)*	*Acipenser sturio+*	Mackiewicz 1989
113.	Poznań 3 (Ostrów Tumski, Wieżowa 2-4) *(N52,24/E16,55)*	*Clupea harengus+, Carassius carassius+, Tinca tinca+, Leuciscus idus+, Leuciscus cephalus+, Chondrostoma nasus+, Rutilus rutilus+, Scardinius erythrophthalmus+, Abramis brama+, Blicca björkna+, Aspius aspius+, Esox lucius+, Perca fluviatilis+, Stizostedion lucioperca+, Gymnocephalus cernuus+*	Dymaczewski 1961; Mackiewicz 1989
114.	Poznań (Ostrów Tumski - Plac Katedralny) *(N52,24/E16,55)*	*Salmo salar+, Tinca tinca+, Rutilus rutilus+, Leuciscus idus+, Scardinius erythrophthalmus+, Aspius aspius+, Abramis brama+, Vimba vimba+, Esox lucius+, Perca fluviatilis+, Stizostedion lucioperca+*	Malinowska 1974; Mackiewicz 1989
115.	Poznań - Zagórze *(N52,24/E16,55)*	*Clupea harengus 2, Cyprinidae 18, Tinca tinca 1, Rutilus rutilus 7, Silurus glanis 1, Esox lucius 11, Perca fluviatilis 8*	N
116.	Pruszcz Gdański 5 *(N54,16/E18,38)*	*Acipenser sturio+, Rutilus rutilus+, Abramis brama+, Pelecus cultratus+, Silurus glanis+, Esox lucius+, Perca fluviatilis+, Stizostedion lucioperca+*	Mackiewicz 1989
117.	Raciąż 1 *(N53,40/E17,47)*	*Acipenser sturio+, Tinca tinca+, Leuciscus idus+, Abramis brama+, Blicca björkna+, Alburnus alburnus+, Vimba vimba+, Esox lucius+, Perca fluviatilis+, Stizostedion lucioperca+*	Mackiewicz 1989
118.	Santok 1 *(N52,44/E15,25)*	*Thymalus thymalus+, Carassius carassius+, Barbus barbus+, Leuciscus idus+, Leuciscus cephalus+, Leuciscus leuciscus+, Chondrostoma nasus+, Rutilus rutilus+, Scardinius erythrophthalmus+, Abramis ballerus+, Abramis brama+, Pelecus cultratus+, Aspius aspius+, Esox lucius+, Perca fluviatilis+, Stizostedion lucioperca+, Gymnocephalus cernuus+*	Hensel & Hilczer-Kurnatowska 1987
119.	Santok 1, 2 *(N52,44/E15,25)*	*Acipenser sturio 1, Cyprinidae 3, Leuciscus idus 2, Aspius aspius 1, Tinca tinca 2, Silurus glanis 51, Esox lucius 13*	N
120.	Santok 2 *(N52,44/E15,25)*	*Leuciscus idus+, Leuciscus cephalus+, Leuciscus leuciscus+, Rutilus rutilus+, Abramis brama+, Blicca björkna+, Pelecus cultratus+, Silurus glanis+, Esox lucius+, Perca fluviatilis+, Stizostedion lucioperca+*	Hensel & Hilczer-Kurnatowska 1987
121.	Sąsiadka *(N50,45/E22,53)*	*Esox lucius 1*	Krysiak 1966
122.	Sopot 1 *(N54,27/E18,34)*	*Gadus morhua 1, Clupeidae 2, Acipenser sturio 14,Cyprinidae 5, Esox lucius 1, Stizostedion lucioperca 2*	Makowiecki 1998a,b; N
123.	Spławie 2 *(N52,09/E17,48)*	*Cyprinidae 5, Esox lucius 5*	N
124.	Szczecin (suburb – Pływacka) *(N53,25/E14,35)*	*Acipenser sturio 14, Carassius carassius 1, Tinca tinca 7, Rutilus rutilus 76, Abramis brama 136, Blicca björkna 1, Aspius aspius 1, Silurus glanis 10, Esox lucius 17, Perca fluviatilis 47, Stizostedion lucioperca 152*	Rulewicz 1994
125.	Szczecin (Rynek Warzywny) *(N53,25/E14,35)*	*Acipenser sturio 214, Anguilla anguilla 56, Carassius carassius 18, Tinca tinca 704, Leuciscus idus 27, Leuciscus cephalus 10, Rutilus rutilus 979, Scardinius erythrophthalmus 12, Abramis ballerus 21, Blicca björkna 3, Abramis brama 1533, Vimba vimba 5, Pelecus cultratus 1, Aspius aspius 98, Silurus glanis 588, Esox*	Rulewicz 1994

TABLE 1 (cont.)

Catalogue of fish remains from Poland. Sites arranged to climatic and archaeological periods.

No	Site	Fish species	References
		lucius 264, Perca fluviatilis 292, Stizostedion lucioperca 1101	
126.	Szczecin (Grodzka) *(N53,25/E14,35)*	*Acipenser sturio 3, Tinca tinca 7, Rutilus rutilus 14, Abramis brama 43, Aspius aspius 4, Barbus barbus 1, Scardinius erythrophthalmus (scales), Silurus glanis 13, Esox lucius 6, Perca fluviatilis 8, Stizostedion lucioperca 30*	Chełkowski 1966;
127.	Szczecin (Wzgórze Zamkowe) *(N53,25/E14,35)*	*Acipenser sturio 7, Anguilla anguilla 12, Carassius carassius 1, Tinca tinca 43, Leuciscus idus 7, Leuciscus cephalus 1, Rutilus rutilus 200, Abramis brama 465, Abramis ballerus+, Blicca björkna+, Aspius aspius 7, Pelecus cultratus+, Vimba vimba+, Silurus glanis 23, Esox lucius 62, Perca fluviatilis 53, Stizostedion lucioperca 245*	Chełkowski 1965b; Rulewicz 1994
128.	Szczecin – Mścięcino *(N53,25/E14,35)*	*Acipenser sturio 101, Anguilla anguilla 14, Tinca tinca 25, Rutilus rutilus 81, Abramis brama 66, Aspius aspius 3, Silurus glanis 32, Esox lucius 10, Perca fluviatilis 13, Stizostedion lucioperca 345*	Chełkowski 1959
129.	Szeligi 2a *(N52,31/E19,52)*	*Barbus barbus+, Rutilus rutilus+, Abramis ballerus+, Abramis brama+, Silurus glanis+, Esox lucius+*	Iwaszkiewicz 1967
130.	Warszawa – Bródno Stare *(N52,15/E21,00)*	*Acipenser sturio 1*	Krysiak 1956
131.	Wolin 1(Old Town) *(N53,51/E14,37)*	*Clupea harengus 10, Acipenser sturio 304, Anguilla anguilla 16, Salmonidae 2, Rutilus rutilus 136, Leuciscus idus 8, Aspius aspius 11, Tinca tinca 11, Abramis brama 540, Abramis ballerus 1, Vimba vimba 2, Silurus glanis 7 Esox lucius 48, Stizostedion lucioperca 1169, Perca fluviatilis 315, Gymnocephalus cernuus 4*	Chełkowski, Filipiak & Chełkowska (in press)
132.	żółwin 29 – GAZ 63 *(N52,28/E15,39)*	*Cyprinidae 8*	Makowiecki 1998d
		Sub-Atlantic – Middle Ages/ Modern Age	
133.	Lubiń *(N51,58/E16,54)*	*Acipenser sturio 3, Abramis brama 43, Rutilus rutilus 19, Tinca tinca 12, Carassius carassius 6, Silurus glanis 7, Esox lucius 70, Perca fluviatilis 56, Stizostedion lucioperca 6*	Iwaszkiewicz 1990
		Sub-Atlantic – Late Middle Ages (1250/1350 – 1500)	
134.	Bierzwnik 25 *(N53,05/E15,40)*	*Cyprinidae 65, Tinca tinca 7, Rutilus rutilus 1, Silurus glanis 2, Esox lucius 16, Percidae 3, Perca fluviatilis 21*	N
135.	Gdańsk (Młyńska) *(N 54,21/E 18,40)*	*Acipenser sturio 3*	N
136.	Gdańsk, Olejarna 2 *(N 54,21/E 18,40)*	*Gadus morhua 18, Pleuronectidae 1, Acipenser sturio 55, Cyprinidae 16, Rutilus rutilus 1, Abramis brama 4, Silurus glanis 1, Esox lucius 4, Stizostedion lucioperca 7*	N
137.	Inowrocław 19 *(N52,48/E18,16)*	*Acipenser sturio 7, Tinca tinca 3, Abramis brama 4, Aspius aspius 3, Silurus glanis 1, Esox lucius 5*	Iwaszkiewicz 1979a
138.	Kołobrzeg (Gierczaka) *(N54,11/E15,35)*	*Clupea harengus 1, Gadus morhua 10, Pleuronectidae 3, Acipenser sturio 10, Abramis brama 2, Perca fluviatilis 3*	N
139.	Kołobrzeg – Market *(N54,11/E15,35)*	*Gadus morhua 15, Acipenser sturio 2, Cyprinidae 1, Esox lucius 1, Stizostedion lucioperca 3*	N
140.	Kołobrzeg (Armii Krajowej, A19) *(N54,11/E15,35)*	*Gadus morhua 17, Clupea harengus 8, Pleuronectidae 4, Acipenser sturio 8, Cyprinidae 7, Esox lucius 4, Perca fluviatilis 2, Stizostedion lucioperca 5*	N
141.	Kołobrzeg (Ratuszowa 9–13) *(N54,11/E15,35)*	*Clupea harengus 28, Gadus morhua 14, Acipenser sturio 4, Anguilla anguilla 14, Cyprinidae 8, Percidae 2*	Makowieccy1996
142.	Kołobrzeg (Narutowicza 36) *(N54,11/E15,35)*	*Gadus morhua 2*	N
143.	Mała Nieszawka *(N52,59/E18,33)*	*Gadus morhua 982, Clupea harengus 16, Acipenser sturio 31, Anguilla anguilla 8, Cyprinidae 137, Abramis brama 20, Rutilus rutilus 2, Scardinius erythrophthalmus 1, Tinca tinca 3,*	Iwaszkiewicz 1991, N

TABLE 1 (cont.)

Catalogue of fish remains from Poland. Sites arranged to climatic and archaeological periods.

No	Site	Fish species	References
		Carassius carassius 1, Aspius aspius 1, Silurus glanis 5, Esox lucius 72, Perca fluviatilis 9, Stizostedion lucioperca 13	
144.	Nowe Miasto upon Warta river *(N51,06/E17,25)*	*Silurus glanis 1, Esox lucius 1, Stizostedion lucioperca 15*	N
145.	Pobiedziska 1 *(N52,28/E17,18)*	*Anguilla anguilla 1*	N
146.	Rybitwy – Ledniczka 4 *(N52,32/E17,23)*	*Salmonidae 1, Silurus glanis 3, Esox lucius 3, Perca fluviatilis 3*	Makowiecki 1997
		Sub-Atlantic – Middle Ages	
147.	Gdańsk (seat of the prince) *(N 54,21/E 18,40)*	*Clupeidae 19, Acipenser sturio 432, Anguilla anguilla 1, Cyprinidae 8, Carassius carasius* (scales), *Tinca tinca 2, Rutilus rutilus 2, Abramis brama 12, Aspius aspius 1, Silurus glanis 4, Esox lucius 1, Perca fluviatilis 2, Stizostedion lucioperca 17*	Susłowska 1966
148.	Gdańsk 1 *(N 54,21/E 18,40)*	*Clupeidae 342, Clupea harengus+, Alosa alosa +, Gadus morhua 10, Pleuronectidae 42, Acipenser sturio 4994, Anguilla anguilla 4, Salmonidae 3, Cyprinidae 1612, Cyprinus carpio+, Carassius carassius 13, Tinca tinca 297, Leuciscus idus 16, Luciscus cephalus 5, Rutilus rutilus 171, Scardinius erythrophthalmus 14, Abramis brama 1454,Blicca björkna 42, Pelecus cultratus 12, Aspius aspius 143,Vimba vimba 92,Barbus barbus+, Silurus glanis 113, Esox lucius 331, Perca fluviatilis 234, Stizostedion lucioperca 2977*	Dąbczewski 1952; Susłowska & Urbanowicz 1967; Rulewicz 1994
149.	Gniew 2 *(N53,50/E18,50)*	*Acipenser sturio 3, Silurus glanis 7, Esox lucius 1, Stizostedion lucioperca 2*	N
150.	Gniezno 13b *(N52,33/E17,36)*	*Acipenser sturio+, Cyprinidae+, Aspius aspius+, Silurus glanis+, Esox lucius+*	Mackiewicz 1989
151.	Góra 1 near Pobiedziska *(N52,27/E17,13)*	*Cyprinidae 16, Tinca tinca 7, Abramis brama 3, Silurus glanis 1, Esox lucius 4*	N
152.	Łekno 3 *(N51,51/E17,18)*	*Acipenser sturio 4, Cyprinidae 44, Tinca tinca 12, Leuciscus idus 1, Rutilus rutilus 4, Abramis brama 6, Blicca björkna 1, Silurus glanis 8, Esox lucius 28, Perca fluviatilis 11*	N
153.	Łęczyca 1 *(N52,04/E19,13)*	*Acipenser sturio+, Esox lucius+*	Mackiewicz 1989
154.	Nakło 1 *(N53,09/E17,36)*	*Acipenser sturio+, Salmo trutta+, Cyprinidae+, Carassius carassius+, Tinca tinca+, Barbus barbus+, Rutilus rutilus+, Silurus glanis+, Esox lucius+, Perca fluviatilis+, Stizostedion lucioperca+*	Mackiewicz 1989
155.	Nakło 1 *(N53,09/E17,36)*	*Cyprinidae 2, Tinca tinca 6, Silurus glanis 3, Esox lucius 4, Perca fluviatilis 2*	N
156.	Niestronno 1 *(N52,42/E17,50)*	*Rutilus rutilus+, Scardinius erythrophthalmus+*	Mackiewicz 1989
157.	Poznań (Ostrów Tumski 13) *(N52,24/E16,55)*	*Acipenser sturio 1, Anguilla anguilla 7, Salmonidae 1, Carassius carassius 6, Tinca tinca 40, Leuciscus idus 3, Rutilus rutilus 87, Scardinius erythrophthalmus 2, Abramis ballerus 1, Abramis brama 55, Blicca björkna 2, Aspius aspius 6, Vimba vimba 6, Silurus glanis 4, Esox lucius 86, Perca fluviatilis 88, Gymnocephalus cernuus 2*	Kaj 1960
158.	Stare Drawsko *(N53,35/E16,10)*	*Anguilla anguilla 3, Cyprinidae 92, Rutilus rutilus 18, Scardinius erythrophthalmus 4, Abramis brama 3, Silurus glanis 2, Esox lucius 50, Percidae 6, Perca fluviatilis 78, Lota lota 1*	N
159.	Ujście 1, 2 *(N53,03/E16,45)*	*Clupea harengus+, Abramis brama+, Perca fluviatilis+, Carassius carassius+, Rutilus rutilus+, Barbus barbus+, Leuciscus idus+, Leuciscus cephalus+, Esox lucius+*	Iwaszkiewicz 1975b
160.	Wrocław (Ostrów Tumski) *(N51,06/E17,02)*	*Clupea harengus 16, Acipenser sturio 3, Salmonidae 17, Salmo salar 1, Salmo trutta 2, Cyprinus carpio 29, Carassius carassius 8, Tinca tinca 12, Barbus barbus 7, Leuciscus idus 19, Leuciscus*	Kozikowska 1974

TABLE 1 (cont.)

Catalogue of fish remains from Poland. Sites arranged to climatic and archaeological periods.

No	Site	Fish species	References
		cephalus 5, Leuciscus leuciscus 3, Rutilus rutilus 6, Scardinius erythrophthalmus 6, Abramis brama 74, Aspius aspius 2, Silurus glanis 11, Esox lucius 30, Perca fluviatilis 23, Stizostedion lucioperca 14	
Sub-Atlantic – Late Middle Ages/Modern Age (1250/1350 – 1700/1800)			
161.	Gdańsk (Hewlius Square) *(N 54,21/E 18,40)*	*Gadus morhua 23, Belone belone 1, Acipenser sturio 100, Cyprinidae 9, Tinca tinca 1, Silurus glanis 1, Esox lucius 17, Precidae 5*	Makowiecki 1998, N
162.	Gdańsk (Kładki 24) *(N 54,21/E 18,40)*	*Gadus morhua 40, Pleuronectidae 8, Scophthalmus maximus 2, Acipenser sturio 32, Salmonidae 1, Cyprinidae 2, Cyprinus carpio 3, Abramis brama 2, Tinca tinca 2, Silurus glanis 6, Esox lucius 30, Stizostedion lucioperca 4*	Makowiecki 1998b, N
163.	Gdańsk (Na Piaskach) *(N 54,21/E 18,40)*	*Gadus morhua 1, Acipenser sturio 17, Silurus glanis 1*	N
164.	Gdańsk (Granary Island) *(N 54,21/E 18,40)*	*Gadus morhua 123, Cyprinidae 3, Pleuronectidae 13, Acipenser sturio 40, Abramis brama 13, Aspius aspius 3, Silurus glanis 6, Esox lucius 42, Stizostedion lucioperca 22*	Makowiecki 1998b
Sub-Atlantic – Modern Age			
165.	Gdańsk (Długie Ogrody) *(N 54,21/E 18,40)*	*Gadus morhua 12, Acipenser sturio 5, Cyprinidae 1, Abramis brama 1, Esox lucius 8, Stizostedion lucioperca 7*	N
166.	Gdańsk (Młyńska) *(N 54,21/E 18,40)*	*Clupea harengus 9, Pleuronectidae 11, Cyprinidae 5*	N
167.	Poznań (Szyperska) *(N52,24/E16,55)*	*Gadus morhua 2, Silurus glanis 3*	N

N – material studied or revisited by D. Makowiecki
+ - indicates the occurrence of the species

TABLE 1 (cont.)
Catalogue of fish remains from Poland. Sites arranged to climatic and archaeological periods.

TEMPORAL AND REGIONAL DISTRIBUTION OF ASSEMBLAGES

The possibilities for studying problems of the Holocene evolution of the Polish ichthyofauna on the basis of subfossil remains are largely determined by the quality of the available data, the temporal distribution of assemblages, species composition or richness and other variables. One very important aspect is the temporal distribution of the collections that is presented in Figure 1. It shows the distribution of recorded archaeoichthyofaunas from Poland by climatic periods. As can be seen, most of the materials belong to the Sub-Atlantic, in particular the Middle Ages (Table 1). In contrast, assemblages from the early and middle Holocene are poorly represented in the faunal record. The regional distribution of the fish bone assemblages is illustrated in Figure 2 for the chronologically older periods (Late Pleistocene - Sub-Boreal) and in Figure 3 for the chronologically youngest period (Sub-Atlantic). Both figures exhibit a similar distribution pattern with the north and the central part of Poland delivering most collections of fish remains. Figure 4 presents an overview of the occurrence of selected fish species in Polish water bodies confirmed by the archaeoichthyological record.

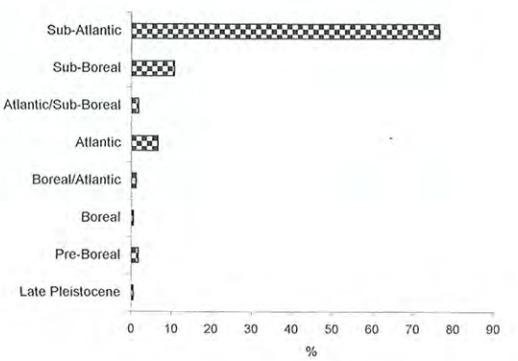

FIGURE 1
Frequency of fish collections from Poland according to climatic periods, (n=167).

Fish species	Sites (see Table 1)
Marine fishes	
Herrings *Clupeidae*	33, 119, 122, 147, 148
Herring *Clupea harengus L.*	33, 75,78, 86, 90, 92, 94, 113, 115, 131, 138, 140, 14,1 143, 148, 159, 160, 166
Allis (allice) *Alosa alosa L.*	148
Cod *Gadus morhua L.*	33, 77, 92, 122, 136, 138-143, 148, 161-164, 167
Flatfishes *Pleuronectidae*	33, 77, 136, 138, 140, 148, 162, 164, 166
Flounder *Platichthys flesus (L.)*	33, 92
Turbot *Psetta maxima (L.)*	162
Cottus sp.	92
Garfish (garpike hornfish) *Belone belone (L.)*	161
Anadromus fishes	
Sturgeon *Acipenser sturio L.*	24, 33, 45, 47, 48, 50, 62,67, 71, 72 75-80, 82, 86, 88, 90, 92, 94-96, 102, 103, 108-110, 112, 116, 117, 119, 122, 124-128, 130, 131, 133, 135-141, 143, 147-150, 152-154, 157, 160-164
Salmons *Salmonidae*	1, 11, 67, 78, 86, 90, 108, 131, 146, 148, 157, 160, 162
Salmon *Salmo salar (L.)*	80, 92, 94, 95, 114, 160
Sea trout *Salmo trutta trutta m. trutta L.*	45, 50, 99
Freshwater fishes	
Brown trout *Salmo trutta trutta m. fario L.*	54
Grayling *Thymallus thymallus (L.)*	118
White fish *Coregonus albula (L.)*	94, 95
Pollan *Coregonus lavaretus (L.)*	148
Eel *Anguilla anguilla (L.)*	11, 20, 22, 33, 92, 125, 127, 128, 131, 141, 143, 145, 147, 148, 157, 158
Carps *Cyprinidae*	1, 2, 4-6, 8-11, 13-20, 22, 25, 29, 31-37, 49, 52, 53, 56, 57, 65-68, 75, 77, 80, 84, 86, 96, 100, 103-105, 107, 108, 115, 122, 123, 132, 134, 136, 139-141, 143, 146-148, 150-152, 154, 155, 158, 161, 162, 164-166
Roach *Rutilus rutilus L.*	4-6, 8-10, 11, 13, 15-22, 24, 32, 33, 36, 39-45, 48, 50, 52, 55, 58-60, 62-64, 68, 70, 71, 74, 75, 77, 78, 80, 82, 86, 88-95, 98, 105, 106, 108, 111, 113-116, 118, 120, 124-129, 131, 133, 134, 136,143, 147, 148, 152, 154, 156-160
Dace *Leuciscus leuciscus (L.)*	52, 118, 120, 160
Chub *Leuciscus cephalus (L.)*	5, 15, 52, 68, 90, 94, 95, 108, 113, 118, 120, 125, 127, 148, 159, 160

TABLE 2

List of fish species identified from archaeological sites in Poland.

Fish species	Sites (see Table 1)
Ide, Orfe *Leuciscus idus (L.)*	7, 10, 19, 24, 50, 62, 68, 75, 77, 90, 94-96, 108, 113, 114, 117-120, 125, 127, 131, 148, 152, 157, 159, 160
Rudd *Scardinius erythrophthalmus (L.)*	10, 13, 18, 19, 21, 24, 40, 52, 58-60, 63, 64, 69, 80, 86-88, 93-96, 98, 105, 111, 113, 114, 118, 125, 148, 156-158, 160,
Asp *Aspius aspius (L.)*	10, 13, 14, 24, 27, 50, 74, 77, 80, 96, 108, 113, 114, 118, 119, 124-128, 131, 137, 143, 147, 148, 150, 157, 160, 164
Tench *Tinca tinca (L.)*	5, 7, 8, 10, 11, 13, 16, 18-20, 22, 24, 25, 32, 46, 52, 60, 63-67, 75, 77-78, 80, 81, 84, 86, 89-91, 94-96, 98-100, 103-105, 108, 109, 111, 113-115, 117, 119, 124-128, 131, 133, 134, 137, 143, 147, 148, 151, 152, 154, 155, 157, 160-162
Beaked carp *Chondrostoma nasus (L.)*	113, 118
Barbel *Barbus barbus (L.)*	62, 72, 74, 118, 126, 129, 148, 154, 159, 160
Bleak *Alburnus alburnus (L.)*	36, 58, 80, 111, 117
White bream, silver bream *Blicca björkna (L.)*	36, 42, 45, 50, 58, 60, 63, 74, 78, 89, 90, 94, 101, 111, 113, 117, 120, 124, 125, 127, 148, 152, 157
Bream *Abramis brama (L.)*	10, 11, 13, 15, 16, 19, 21, 22, 24, 25, 31-33, 36, 41, 42, 44-46, 48, 50-52, 55-60, 62-65, 69-72, 74, 77-82, 86-95, 97-100, 104, 107, 108, 111, 113, 114, 116-118, 120, 124-129, 131, 133, 136-138, 143, 147, 148, 151, 152, 157-160, 164,165
Blue bream *Abramis ballerus (L.)*	10, 15, 118, 125, 127, 129, 131, 157
Zarthe *Vimba vimba (L.)*	11, 50, 80, 89, 92, 114, 117, 125, 127, 131, 148, 157
Sichel *Pelecus cultratus (L.)*	45, 50, 82, 116, 118, 120, 125, 127, 148,
Crucian carp *Carassius carassius (L.)*	5, 10, 13, 19, 44, 50, 60, 64, 78, 87, 80, 93-95, 98, 111, 113, 118, 124, 125, 127, 133, 143 147, 148, 154, 157, 159, 160
Carp *Cyprinus carpio f. domestica*	80, 148, 160, 162
Catfish *Silurus glanis L.*	2, 8, 11, 16, 19-22, 24, 31, 32, 35, 42, 48, 50, 52, 58-61, 63, 65, 67, 68, 71, 77-80, 83, 85-88, 94, 96, 97, 99-101, 106, 108, 109, 115, 116, 119, 120, 124-129, 131, 133, 134, 136, 137, 143, 144, 146-152, 154, 155, 157, 158, 160-164, 167
Pike *Esox lucius L.*	1-13, 15, 16, 18-20, 22-24, 26, 28, 30-38, 42, 44, 46, 48, 50, 52, 53, 55-60, 62-75, 77-81, 83, 84, 86-94, 96-100, 102-109, 111, 113-129, 131, 133, 134, 136, 137, 139, 140, 143, 144, 146-155, 157-162, 164, 165
Perches *Percidae*	4-6, 8, 15, 19, 20, 22, 31, 56, 66, 77, 80, 86, 108, 134, 141, 158, 161
Perch *Perca fluviatilis* L.	1-6, 8, 10, 11, 13, 16, 18-20, 22, 24, 32-37, 39, 42-44, 50, 52, 56-60, 62-65, 69-71, 74, 75, 77, 80, 82, 86-94, 96, 98, 100, 105, 107-109, 111, 113-118, 120, 124-128, 131, 133, 134, 138, 140, 143, 146-148, 152, 154, 155, 157-160
Piekperch *Stizostedion lucioperca* (L.)	5, 6, 11, 20, 24, 35, 44, 45, 48, 50, 51, 63, 65, 70-72, 77, 80-82, 86, 89-96, 98, 101,102, 108, 111, 113, 114, 116-118, 120, 122, 124-128, 131, 133, 136, 139, 140, 143, 144, 147-149, 154, 160, 162, 164, 165
Ruffe *Gymnocephalus cernua* (L.)	90, 113118, 125, 131, 157
Burbot *Lota lota* (L.)	50, 90, 91, 96, 148, 158
Stickleback *Gasterosteus aculeatus* (L.)	33
Loach *Noemacheilus barbatulus* (L.)	33

TABLE 2 (cont.)

List of fish species identified from archaeological sites in Poland.

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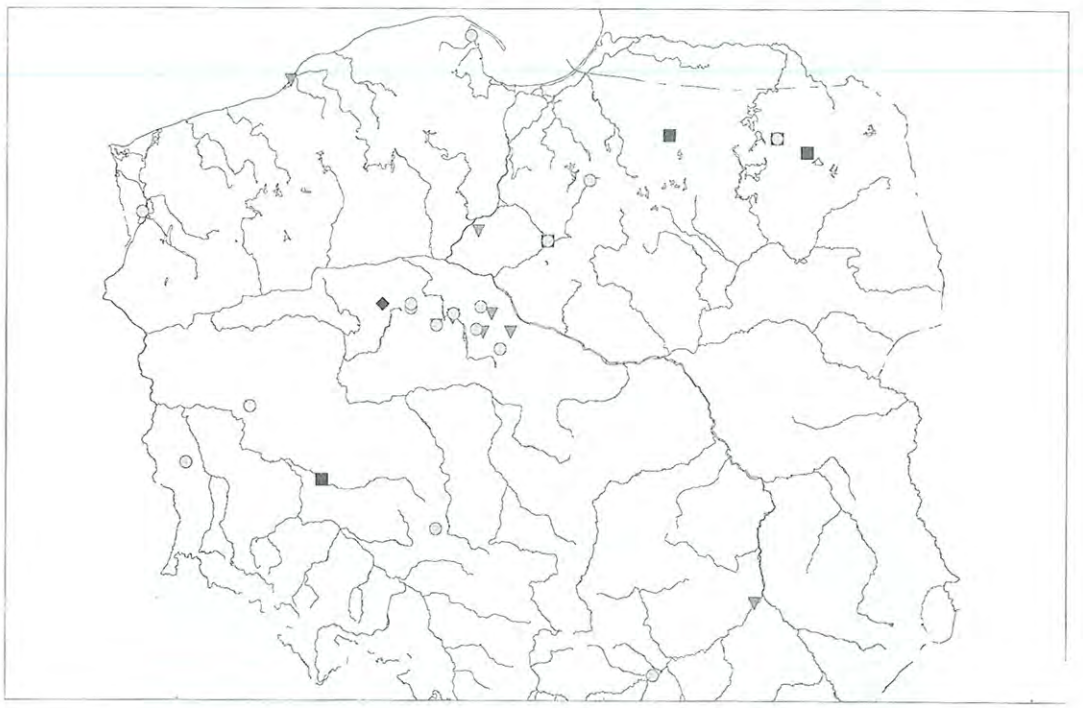

FIGURE 2

Location of Late Pleistocene - Sub-Boreal sites with fish remains. ♦ - Late Pleistocene - Bölling; ■ - Pre-Boreal/Boreal; ▼ - Atlantic; ○ - Sub-Boreal

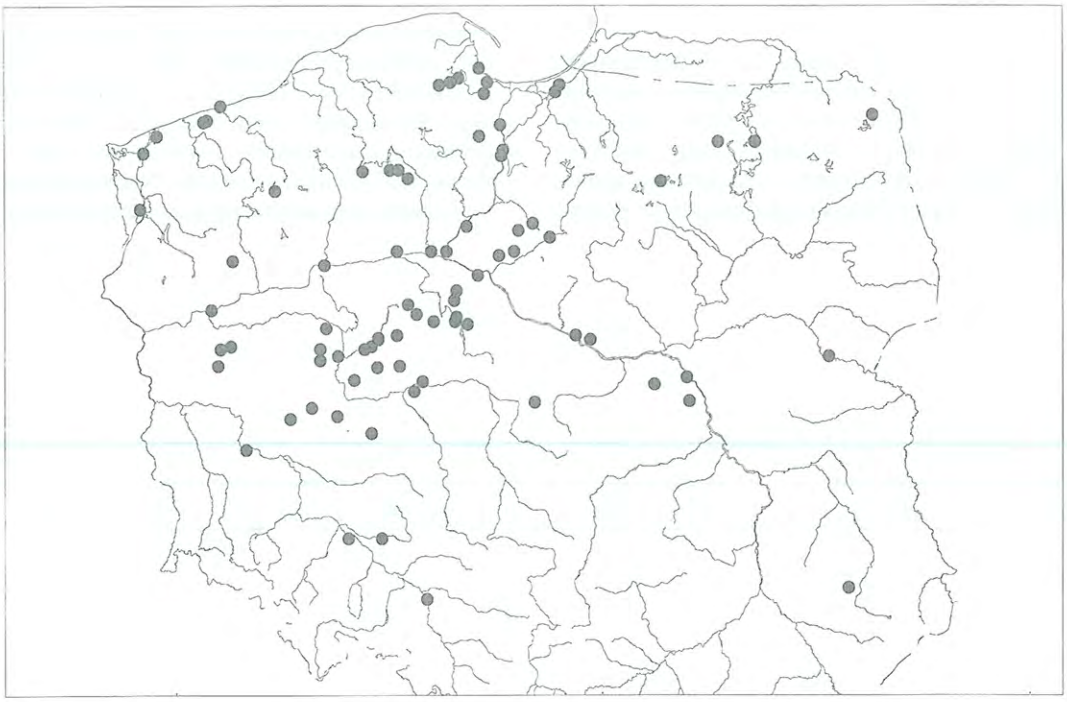

FIGURE 3
Location of Sub-Atlantic sites with fish remains.

Number of collections	1	3	1	2	11	3	18	126
Climatic periods	Late Pleistocene	Pre-Boreal	Boreal	Boreal/ Atlantic	Atlantic	Atlantic/ Sub-Boreal	Sub-Boreal	Sub-Atlantic
Clupea harengus							▬	▬
Gadus morhua					▬	▬	▬	▬
Pleuronectidae							▬	▬
Anguilla anguilla					▬	▬	▬	▬
Acipenser sturio					▬	▬	▬	▬
Salmonidae	▬	▬	▬	▬	▬	▬	▬	▬
Rutilus rutilus		▬	▬	▬	▬	▬	▬	▬
Tinca tinca			▬	▬	▬	▬	▬	▬
Carassius carassius			▬	▬	▬	▬	▬	▬
Leuciscus cephalus			▬	▬	▬	▬	▬	▬
Leuciscus idus				▬	▬	▬	▬	▬
Abramis brama					▬	▬	▬	▬
Aspius aspius					▬	▬	▬	▬
Scardinius erythrophthalmus					▬	▬	▬	▬
Abramis ballerus					▬	▬	▬	▬
Cyprinus carpio f. domestica								▬
Chondrostoma nasus								▬
Leuciscus leuciscus								▬
Pelecus cultratus								▬
Barbus barbus								▬
Silurus glanis		?			▬	▬	▬	▬
Esox lucius	▬	▬	▬	▬	▬	▬	▬	▬
Perca fluviatilis	▬	▬	▬	▬	▬	▬	▬	▬
Stizostedion lucioperca			▬	▬	▬	▬	▬	▬

FIGURE 4
Occurrence of selected fish species in the Polish water bodies according to the archaeoichthyological record.

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Tafonomía de abrigos rocosos de la Puna. Formación de conjuntos escatológicos por zorros y sus implicaciones arqueológicas

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ABSTRACT: Scatological assemblages accumulated by modern carnivores, mainly foxes, in Puna rockshelters are analyzed. The ability to identify these scats, the implications of this Kind of assemblages to the archaeological record, and their significance regarding the relationship between human and fox populations are assessed.

KEY WORDS: TAPHONOMY, CARNIVORES, FORMATION OF SCATOLOGICAL ASSEMBLAGES, ROCKSHELTERS, PUNA, ARGENTINA

RESUMEN: Se analizan conjuntos escatológicos acumulados por carnívoros modernos, principalmente zorros, en abrigos rocosos de la Puna. Se evalúan su identificabilidad, las implicaciones de este tipo de acumulaciones para el registro arqueológico y su significado en el marco de la relación entre las poblaciones humanas y de zorros.

PALABRAS CLAVE: TAFONOMÍA, CARNÍVOROS, FORMACIÓN DE CONJUNTOS ESCATOLÓGICOS, ABRIGOS ROCOSOS, PUNA, ARGENTINA

INTRODUCCIÓN

Este trabajo trata sobre el registro faunístico acumulado a través de excrementos de zorros, y es parte de una investigación sobre los procesos tafonómicos generados por estos carnívoros en abrigos rocosos de la Puna argentina.

Las cuevas, aleros y abrigos en general son de suma importancia para la arqueología de la región, y sin embargo es aún muy poco lo que conocemos sobre algunos de los procesos que han formado ese registro a lo largo del tiempo (Yacobaccio, 1984-85, 1991; Elkin *et al.*, 1991; Nasti, 1991; Olivera, 1992; Caracotche, 1995).

Más específicamente, los abrigos son los destinos finales de trayectorias de transporte de alimento no sólo por parte del hombre sino también de carnívoros (Stiner, 1991, 1994; Behrensmeyer *et al.*, 1992), quienes además de acumular restos faunísticos al transportarlos a sus madrigueras lo hacen a través de sus excrementos, otra vía común de incorporación de material óseo a depósitos fósiles (Andrews, 1990; Stallibrass, 1990; Borrero & Martín, 1993; Schmitt & Juell, 1994). En la Puna, éste es el caso particularmente de zorros (Yacobaccio, 1991; Redford & Eisenberg, 1992; Mondini, 1994, 1995a, b).

Entre las evidencias de procesos no culturales que más han preocupado a los arqueólogos se encuentran precisamente las señales de mordeduras, excrementos y otras trazas de carnívoros, particularmente cánidos, presentes en muchos sitios arqueológicos de la Puna (ver Yacobaccio, 1991; Elkin *et al.*, 1991; Olivera, 1992; Elkin, 1996). Esto implica fundamentalmente que no podemos

asumir una buena integridad de estos registros, ya que la alternancia ocupacional entre los humanos y los carnívoros pudo generar la modificación o destrucción de los restos acumulados por los primeros, así como la superposición o incluso mezcla de aquellos acumulados por ambos. Sin embargo, al momento de comenzar esta investigación prácticamente no se disponía de información que permitiera interpretar estas evidencias y estimar las características particulares de los procesos que las generaron en la región (Nasti, 1991).

En general, muchos estudios tafonómicos sobre carnívoros se han centrado en grandes depredadores y sus efectos en las partes no consumidas de sus presas, principalmente las más grandes (Stallibrass, 1990; Lyman, 1994). Pero los carnívoros también depositan los restos de huesos que han masticado e ingerido a través de sus heces. Si bien los grandes depredadores, más estudiados, no son acumuladores significativos de pequeños mamíferos (Andrews, 1990), los carnívoros de menor porte que se alimentan de presas pequeñas sí pueden serlo. Lamentablemente estos últimos tendieron a estar oscurecidos ante el enorme poder destructivo de las hienas (Stallibrass, 1990), que han atraído tanta atención por parte de los arqueólogos. Desde los años '80 comenzaron a hacerse estudios sistemáticos sobre esta problemática, aunque aún hoy siguen siendo escasos.

En este marco, recientemente se ha realizado un relevamiento de excrementos modernos de zorros de la Puna, cuyo análisis se presenta aquí[1]. Los ejes del análisis consisten en determinar: a) si los conjuntos óseos derivados de excrementos son identificables como tales, y b) su significación en términos de b.1) la integridad del registro arqueológico y b.2) la relación entre las poblaciones de zorros y humanos, relación frecuentemente descrita en términos de comensalismo.

Estos objetivos se relacionan con el hecho de que los excrementos pueden depositarse en diferentes contextos, tales como letrinas, madrigueras, puntos de demarcación de territorios, puntos de consumo (Andrews & Nesbit Evans, 1983; Mondini, 1995a, 1998; Martín, 1998), pero en muchos casos los *loci* usados para estos distintos propósitos coinciden con los utilizados por humanos, especialmente en el caso de los abrigos rocosos, un recurso preciado para ambos. Más precisamente, en la Puna se han registrado excrementos de zorro y de carnívoro en general en distintos sitios arqueológicos, como es el caso de Inca Cueva- cueva 4 y Quebrada Seca 3. Estos excrementos y su significado aún no han sido analizados, ni tampoco se disponía hasta el momento de un análogo moderno relevante con el cual compararlos.

En otras palabras, a diferencia de muchos estudios sobre faunas escatológicas de carnívoros realizados por paleontólogos y por biólogos, esta investigación se centra en los zorros no por sí mismos sino en relación con las poblaciones humanas y el registro arqueológico. Lo que se busca es estudiar sus excrementos desde un punto de vista tafonómico en tanto en cuanto pueden incidir en la formación del registro arqueológico y en nuestras inferencias sobre los comportamientos humanos en el pasado. Las reconstrucciones paleoambientales también son relevantes en este sentido, aunque están más allá de los alcances de este estudio.

Sobre la base de los antecedentes sobre el tema y de la investigación que se ha venido realizando sobre los conjuntos óseos transportados por los carnívoros a los abrigos en cuestión, dominados por artiodáctilos (Mondini, 1994, 1995a), se partió de la hipótesis de que los conjuntos escatológicos del zorro estarían dominados por otro espectro de la fauna, que se sabe forma parte sustancial de su dieta: los roedores y demás taxones pequeños. Además, a partir de diversos estudios sobre los conjuntos escatológicos generados por otros carnívoros, se planteó la hipótesis de que la fragmentación de los especímenes óseos estudiados debería ser llamativa. Se plantearon asimismo una serie de expectativas sobre las características de estos conjuntos que se discuten más abajo, a medida que se presentan los resultados obtenidos.

LOS ZORROS Y SUS MADRIGUERAS

Los principales carnívoros involucrados en el uso de abrigos rocosos en la Puna son dos cánidos silvestres: el zorro colorado (*Pseudalopex culpaeus*) y el zorro gris (*P. griseus*) (Olrog & Lucero, 1981; Meserve *et al.*, 1987; Erlich de Joffe *et al.*, 1988; Ginsberg & Macdonald, 1990; Novaro, 1991; Redford & Eisenberg, 1992). El colorado, el más grande de los zorros sudamericanos, tiene un peso promedio de 5 a 13,5 kg (los machos son 10

[1] Una síntesis de los resultados fue presentada en el 63rd Annual Meeting of the Society for American Archaeology (Mondini, 1998).

a 15% más grandes que las hembras). Su hábitat es de montañas, estepas y pampas, hasta los 4.500 msnm. Tiene una dieta omnívora amplia, aunque según algunos estudios selectiva, basada principalmente en pequeños mamíferos. En áreas donde hay ganado, la proporción de mamíferos más grandes en la dieta tiende a aumentar. El zorro gris tiene un peso promedio de 4,4 kg y vive en planicies, pampas, desiertos y bajas montañas, aunque hemos registrado su presencia a unos 4.000 msnm. Su dieta es similar a la del zorro colorado, aunque algo más amplia y con mayor proporción de invertebrados y frutos. Si bien hay importantes antecedentes tafonómicos sobre estos zorros (Borrero, 1990; Borrero & Martín, 1993), la información tafonómica que se ha buscado generar con esta investigación no era conocida para la Puna hasta el momento.

Los relevamientos se realizaron en el área de Antofagasta de la Sierra, Catamarca. Se trata de un altiplano árido, por encima de los 3.500 msnm, característico de la Puna. Más precisamente, allí se relevaron nueve madrigueras[2] modernas de zorro en el valle del río Punilla y las quebradas subsidiarias Cacao y Curuto, y en un sector de la cuenca de la Laguna Colorada (Figura 1) (Mondini, 1995a, 1995b, 1996). Debe destacarse que todas las prospecciones se limitaron a abrigos rocosos, y que todas las madrigueras provienen de estos *loci*. Algunas contenían sólo huesos, otras sólo excrementos, y otras ambos.

Las madrigueras y/o letrinas que contenían excrementos son ANSm3, ANSm4bis, ANSm5, ANSm7 y ANSm8, siendo ANSm7 la que presentaba la concentración más grande (Tabla 1). ANSm3 y 4bis son probablemente letrinas, ya que sólo contenían excrementos. Ambas se encontraban, sin embargo, a escasos metros de madrigueras que sólo contenían huesos (ANSm2 y 4, respectivamente). Por otra parte, ANSm5, 7 y 8 contenían tanto excrementos como especímenes óseos, en proporciones variables. os excrementos fueron encontrados en superficie, excepto por unos pocos que estaban comenzando a enterrarse en ANSm7.

Los excrementos fueron asignados a zorro en base a sus características morfológicas, con la ayuda del Dr. Marcelo Beccaceci, especialista en cánidos sudamericanos. La excepción son dos

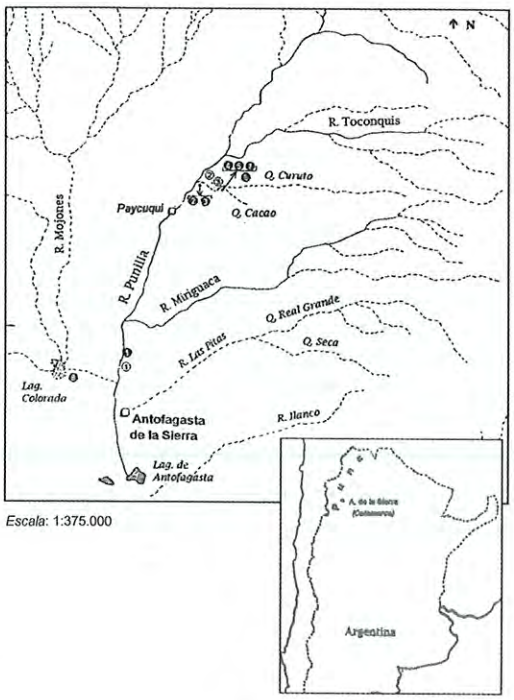

FIGURA 1

El área de estudio. *Referencias:* Q.: Quebrada. Los números indican las diferentes madrigueras, por ej. ❶=ANSm1.

Madriguera	ANSm3	ANSm4 bis	ANSm5	ANSm7	ANSm8 *	Total
n excrementos recuperados	6	4	9	122	4 (+2)	145 (+2)
n excrementos analizados	1	1	1	12	1 (+1)	16 (+1)

TABLA 1

Muestras de excrementos recuperados y analizados. * De los 6 excrementos, 2 no pudieron ser atribuídos con certeza a cánido. Uno de estos últimos también fue analizado, pero dada la ambigüedad de la asignación los resultados no se presentan aquí.

[2] Debe notarse que sólo en casos puntuales se discriminan las letrinas (término aplicado aquí a los casos que consisten únicamente en excrementos) de las madrigueras propiamente dichas (que contienen huesos, y pueden o no contener excrementos). A menos que se mencione esta diferencia, se utiliza el término "madriguera" en sentido genérico. Además, las asignaciones funcionales en estos sitios tafonómicos son inferenciales y presentan los mismos problemas que aquellas en sitios arqueológicos.

excrementos de ANSm8 cuya asignación a esta familia es problemática[3], por lo que fueron excluidos de las comparaciones.

LOS CONJUNTOS ESCATOLÓGICOS

Todos los excrementos fueron descritos y fotografiados. La mayoría se encontraban deshidratados, aunque aquellos que comenzaron a enterrarse no lo estaban tanto como los hallados en superficie, y varios presentaban signos de meteorización, manifiesta en su deshidratación, textura y color (más blanquecino). Estas características seguramente están relacionadas con las áridas condiciones del lugar. El tamaño de los excrementos es variado, y muchos se encontraban fragmentados, generalmente en las estrangulaciones. Aquellos con mayor contenido de pelo parecen haber sido más resistentes a la fragmentación, y algunos se encontraban además muy compactados. A los fines de esta investigación, cada excremento, fragmentado o entero, fue considerado como una unidad, por lo que el número de excrementos originalmente depositado es desconocido.

Luego de registrar estas características generales de los excrementos, se disgregó el 10% (n=16) para analizar sus contenidos (Tabla 1). El muestreo se debió a la necesidad de preservar parte de las muestras sin desintegrar en vistas de posibilidades de análisis futuros. Una razón adicional, pero no menos importante, es la enorme cantidad de tiempo que esta tarea demanda, al tener que desintegrar cada excremento en su totalidad y manipular fragmentos óseos de tamaño ínfimo, muchos de ellos <1 mm. Se buscó incluir en las muestras excrementos de diferentes características, siendo los criterios su tamaño y estado de preservación fundamentalmente. En la Tabla 2 se presenta una síntesis de las principales características de cada uno de los excrementos de zorro analizados.

TABLA 2

Características de los excrementos analizados. 1 Fragmentación: se indica si el excremento está fragmentado ("sí") o completo ("no"). 2 Tamaño: se indica la longitud máxima por el grosor máximo, en mm. 3 Notar que en la categoría "huesos" se incluyen también dientes.

Excremento	F[1]	Tam[2]	Color/ Estado	Contenidos [3]	Observaciones
3/53/F	si	60 x 10	marrón oscuro	huesos- pelo- vegetales- diminutos clastos- sedimento	Los vegetales constituyen casi toda la matriz. Abundante pelo.
4bis/58/D	si	31 x 11	marrón- superficie brillosa	huesos- pelo- insectos- pluma- diminutos clastos- sedimento	El pelo constituye casi toda la matriz. Concentración de pequeñas astillas óseas en un sector con pelusa compactada.
5/70/A	no	39 x 15	muy oscuro	huesos- pelo- vegetales- diminutos clastos- sedimento	Cantidad abundante de vegetales. El pelo podría ser de roedor.
7/87/CS	si	59 x 20	grisáceo con manchas oscuras- compacto	huesos- pelo- queratina- diminutos clastos- sedimento	El pelo constituye casi toda la matriz. Los pequeños clastos son bastante abundantes. La queratina correspondería a garras o uñas.
7/87/CV	si	69 x 18	marrón- cuarteado- descascarado	huesos- pelo- vegetales- diminutos clastos- sedimento	El pelo es escaso, y estaba concentrado en un sector del excremento donde también se concentraban más huesos.
7/87/CY	si	44 x 16	marrón muy oscuro- sector con superficie brillosa	huesos- pelo- sedimento	Algunos huesos son muy oscuros (símil quemados). También los demás contenidos son muy oscuros. Podría tratarse de un proceso químico.
7/87/CZ	si	83 x 18	marrón oscuro	huesos- pelo- vegetales- diminutos clastos	El pelo constituye casi toda la matriz
7/87/DA	si	68 x 17	marrón- parcialmente descascarado- fisurado	huesos- pelo- pluma- vegetales- diminutos clastos	El pelo constituye casi toda la matriz.
7/87/DC	si	24 x 13	marrón oscuro- superficie brillosa- parcialmente descascarado	huesos- pelo- vegetales- piedrita- sedimento	
7/87/DE	si	66 x 17	marrón	huesos- pelo- sedimento	El pelo constituye casi toda la matriz
7/87/DF	si	35 x 16	marrón claro	huesos- plumas- queratina- tejidos blandos- nsectos- vegetales- diminutos clastos- sedimento	Las plumas son abundantes. Incluye un pico de ave. Los tejidos blandos envuelven huesos articulados.
7/87/DI	si	15 x 17	marrón- muy compacto	huesos- pelo- vegetales- diminutos clastos- sedimento	El pelo constituye casi toda la matriz.
7/87/DK	si	28 x 14	marrón claro- matriz muy disgregada	huesos- pelo- tejidos blandos- vegetales- diminutos clastos- sedimento	Además contenía material orgánico no identificado. Los tejidos blandos están tanto adheridos a huesos como sueltos.
7/87/DO	si	21 x 10	marrón- parcialmente descascarado	huesos- pelo- vegetales- diminutos clastos	El pelo constituye casi toda la matriz.
7/91/D	si	19 x 15	blanco- meteorizado	huesos- pelo- sedimento- diminutos clastos	Además contenía material orgánico no identificado.
6/B5/AB	si	38 x 16	oscuro- semi- desintegrado	huesos- insectos- vegetales- sedimento	Pluma adherida.

[3] Las características morfológicas de estos dos excrementos y su color blanquecino presentan cierta semejanza con los excrementos de puma. Sin embargo, a pesar de estas diferencias, uno de ellos fue analizado y las características de sus contenidos óseos no varían sustancialmente de lo observado para los excrementos de cánido. Los pelos contenidos en el excremento, predominantemente de color grisáceo, han sido enviados a analizar, ya que su identificación podría ayudar a resolver esta cuestión. Cabe destacar también que las características de los especímenes óseos transportados a esta madriguera son concordantes con las de otros casos estudiados, e incluso los daños de carnívoro que presentan son predominantemente leves, por lo que de haber intervenido un puma su injerencia en el conjunto debió ser mínima.

Para disectar los excrementos, en la literatura se mencionan al menos dos técnicas generales. Básicamente, una consiste en remojarlos en agua (Stallibrass, 1990) o en alguna solución (Figuerero Torres, 1981), y la otra en disecarlos (Meserve *et al.*, 1987). Dado que los excrementos de la Puna estaban muy deshidratados, se optó por disgregarlos sin tratamiento previo alguno. Se utilizó asimismo una malla de 850 mm para ayudar a separar los especímenes óseos. Cabe destacar que el pelo suele ser muy abundante, y parece derivar tanto de las presas como de los zorros mismos. Otros contenidos incluyen restos vegetales, diminutos clastos, sedimento, restos de insectos, unas pocas plumas y, como veremos, otros tejidos de vertebrados además de huesos. Estos contenidos fueron registrados de un modo general y guardados para potenciales futuros análisis.

Los especímenes óseos y dentarios recuperados (n=1.871) fueron analizados a ojo desnudo y con lupa de bajos aumentos (2 a 4*x*). Aquellos procedentes de cada excremento fueron considerados un conjunto[4]. En general, los conjuntos derivados de cada excremento tienen entre 6 y 532 especímenes, con un promedio de 117, aunque la mayoría son más exiguos (en 10 casos <100 especímenes). La mayor parte de los especímenes (83% del total) proviene de ANSm7, donde no sólo se recuperó la mayor cantidad de excrementos sino también los conjuntos más grandes (Figura 2).

Debe destacarse aquí que estas cifras deben considerarse en general como mínimas, especialmente en relación a los especímenes más pequeños. En efecto, muchos especímenes <1 mm no pudieron ser manipulados, por lo que esta categoría de tamaño está en un sentido subrepresentada (ver Figura 3). Este límite es consistente con otros estudios (Stallibrass, 1990), aunque en muchos otros el límite de recuperación, una decisión en gran medida metodológica, se ha puesto en un tamaño aún mayor (Schmitt & Juell, 1994). Lamentablemente, en algunos trabajos esta decisión no es explícita, lo que complica las comparaciones. Por otra parte, algunos especímenes en muy mal estado de preservación simplemente se desintegraron al intentar manipularlos. Además algunos especímenes de los conjuntos 4bis/58/D, 7/87/CZ y 7/87/DF estaban articulados y cubiertos por tejidos, por lo que no todos pudieron contabilizarse. Sólo se hizo una excepción en el caso de cuatro patas completos de roedor registrados en el conjunto 7/87/CZ: a los efectos de estos análisis se computaron como conteniendo todas las falanges (n=56)[5], y ningún otro elemento. A pesar de estas consideraciones, puede plantearse que estas cifras proporcionan una medida confiable de la magnitud de las acumulaciones que podemos esperar.

De acuerdo con la literatura, hay tres clases principales de consecuencias tafonómicas de la ingestión de huesos y dientes: fragmentación, destrucción total y modificaciones por digestión (Andrews, 1990). Las dos primeras son causadas

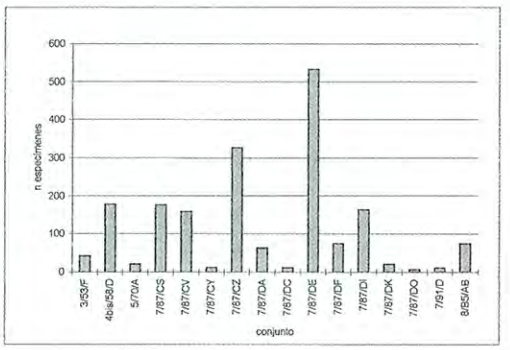

FIGURA 2
Tamaño de las muestras por conjunto.

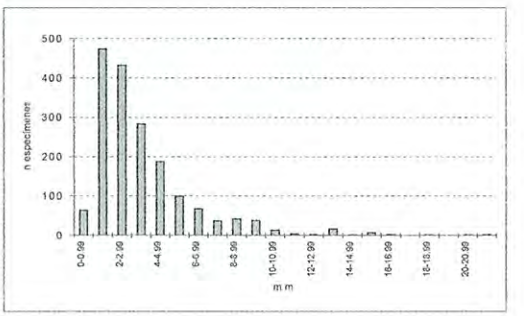

FIGURA 3
Totales de tamaño de los especímenes (sumando todos los conjuntos).

[4] La denominación de cada conjunto tiene tres partes: el número que identifica a la madriguera (ej. 7 para ANSm7), el número de rótulo con que fue embolsado durante la recolección (número que se aplica al mapeo en planta), y finalmente letras consecutivas para cada excremento individual.

[5] Debe destacarse que estas falanges son excluidas de los cálculos que describen las modificaciones óseas.

tanto por la acción de los dientes del carnívoro como por el proceso digestivo en sí, mientras que la tercera se debe exclusivamente a este último y, por lo tanto, su potencial para identificar conjuntos escatológicos en el registro fósil es crucial.

Más del 85% del total de especímenes analizados están fragmentados, y en algunos conjuntos ninguno está completo. El porcentaje de fragmentación varía en efecto entre 17% y 100% en los distintos casos, aunque el promedio es de casi 83%.

El tamaño de las partículas óseas y dentarias denota una fragmentación extrema (Figura 2). Si bien cerca del 2% del total de especímenes no pudieron medirse debido a que estaban cubiertos por tejidos o, en el caso de los dientes, insertos en alvéolos, el tamaño (longitud máxima) medio por conjunto varía entre 3 y 7 mm (Figura 4). Sumando todos, el 55% de los especímenes mide menos de 3 mm, aún cuando los más pequeños están subrepresentados (Figura 5). Los especímenes raramente exceden 1 cm, y los más grandes apenas superan los 2 cm, y esto parece ser independiente del tamaño del taxón o del hueso consumido, lo cual es consistente con otros estudios (Stallibrass, 1990).

Para descartar la posibilidad de que el tamaño de los especímenes estuviera condicionado por el pequeño tamaño de algunas muestras, estos fueron representados en escala logarítmica, a fín de poder comparar la forma de ambas curvas. Como puede verse en la Figura 5, el tamaño de los conjuntos podría afectar al de los especímenes sólo hasta un tamaño de muestra de n=20, mientras que en los conjuntos más grandes las variables serían independientes. De todos modos, el tamaño de los especímenes de las muestras más pequeñas no difiere del de las más grandes, por lo que puede considerarse que la tendencia a tamaños diminutos de fragmentos óseos y dentarios es una inferencia válida.

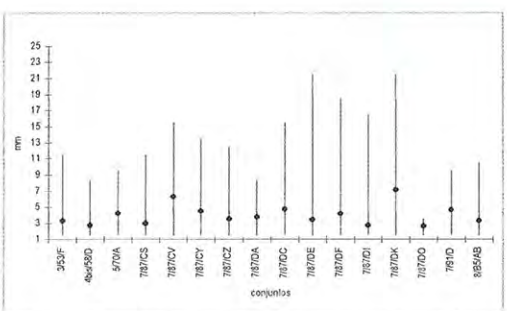

FIGURA 4

Medidas máximas, mínimas y promedio de especímenes por conjunto.

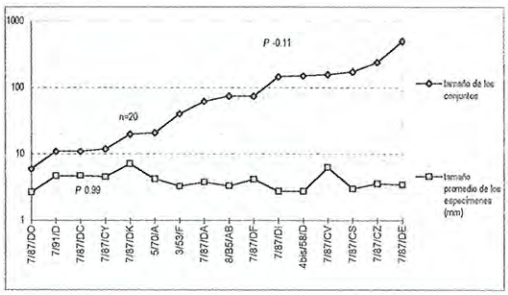

FIGURA 5

Tamaño de los especímenes (excluyendo aquellos <1mn) comparado con el tamaño de los conjuntos.

Debido en gran medida a esta severa fragmentación, la determinación anatómica y taxonómica fue realizada en un grano grueso. Esta resolución es de todos modos concordante con algunos otros estudios con los que se realizaron comparaciones y, sobre todo, con las preguntas que dirigen esta investigación.

Un promedio de 28% de los especímenes (entre 8% y 67% por conjunto) pudo ser identificado en algún grado, al menos, por ejemplo, como "hueso largo de pequeño mamífero". La identificabilidad parece decrecer a medida que aumenta el tamaño corporal de la presa. Estos bajos niveles de identificabilidad son consistentes con otros estudios (Payne & Munson, 1985; Andrews, 1990; Stallibrass, 1990). Como ha mostrado Andrews (1990) en su exhaustivo estudio comparativo, los carnívoros suelen producir un daño extremo en los huesos, debido a que suman la acción de los dientes al paso por el tracto digestivo, el cual, a diferencia de las aves depredadoras, incluye no sólo el estómago sino también los intestinos.

En todos los conjuntos se identificaron roedores, principalmente pequeños, que corresponderían a las clases "a" y "b" de pequeños mamíferos (*sensu* Andrews & Nesbit Evans, 1983, es decir, <1 kg). Un taxón más grande (aparentemente clase "c", es decir, 1-5 kg), que puede ser un roedor de mayor tamaño que el promedio o un lagomorfo, fue identificado en dos conjuntos (7/87/CY y 7/87/DA). En un caso (7/87/CV) se identificó una lagartija. En cuatro conjuntos (7/87/CS, 7/87/DF, 7/87/DI y 7/87/DK) se identificaron aves, que en los tres primeros parecen ser el taxón dominante. Finalmente, en el conjunto 7/91/D se identificó un taxón más grande que puede ser cualquier mamífero mediano o grande (>5 kg), incluso un ungula-

do, aunque la fragmentación de estos especímenes impide una determinación más precisa.

En síntesis, excepto en este último caso, todos los conjuntos consisten en pequeños mamíferos y otros vertebrados de tamaño corporal equivalente. Esto difiere notablemente de los conjuntos transportados a las mismas madrigueras, dominados por ovicápridos y camélidos (Mondini, 1994, 1995a y b, 1996)[6]. De no considerar ambas clases de conjuntos podríamos obtener una visión poco representativa de la dieta de estos cánidos, así como de los procesos tafonómicos que generan.

Es por lo tanto importante distinguir dos cuestiones: si estos carnívoros ingieren parte de los huesos de los animales (o segmentos de animales) más grandes de los que se alimentan, y si lo hacen, si estos huesos son identificables. Lamentablemente, no existe mucha información sobre la frecuencia o las condiciones bajo las cuales los carnívoros ingieren especímenes óseos de animales de igual o mayor tamaño corporal a sí mismos. Aunque puede decirse que en comparación con las presas pequeñas ingieren una menor proporción de partes esqueléticas por individuo o parte consumida, esto debería evaluarse también en términos de volumen. De todos modos debemos tener en cuenta la segunda cuestión. Los experimentos llevados a cabo por Payne & Munson (1985) con perros domésticos han mostrado que la identificabilidad de huesos de cabra en sus excrementos es de aproximadamente 1%, mientras que es mucho mayor para los taxones más pequeños. Esto resulta particularmente interesante si consideramos que la cantidad de especímenes en los excrementos, comparada con la cantidad de huesos que se proveyó a los perros, no parece covariar con el tamaño de la presa, como sí lo hace la identificabilidad. Este tipo de estudios es particularmente relevante debido a que el *input* de huesos es conocido. De todos modos, otros estudios también muestran que cuando se detectan huesos de presas grandes, éstos no son determinables anatómicamente, y mucho menos a nivel de especie (Stallibrass, 1990). En suma, es difícil saber cuándo los zorros decidirán consumir presas más grandes o más pequeñas (aunque aparentemente estas últimas suelen constituir el grueso de su dieta) o sus huesos, pero aún si mantuviéramos ambos factores constantes debemos esperar un sesgo importante en la identificabilidad de aquellas más grandes.

En general, los elementos más abundantes son los dientes, los huesos largos y las falanges (Figura 6). Ninguno de los dientes se encuentra en los conjuntos en los que predominan las aves, en los que en cambio se registró un pico. Debe recordarse que aquí se asume que para las cuatro patas completos de roedor de 7/87/CZ, todas las falanges (n=56) están representadas. Las lagartijas están representadas por tres mandíbulas, aunque podría haber otros huesos no identificados. Solamente un espécimen, un fragmento de diente, pudo identificarse anatómicamente para el mamífero que podría ser de mayor talla.

Mientras que las frecuencias anatómicas son en general consistentes con otros estudios sobre cánidos (Stallibrass, 1990), las vértebras están menos representadas que en algunos de los conjuntos comparados (Andrews, 1990). Dado que constituyen una de las partes más susceptibles de destrucción, esto sugeriría altos niveles de atrición, aunque teniendo en cuenta que los ácidos digestivos no parecen haber causado un daño sustancial es muy probable que esta atrición se deba principalmente a la acción masticadora de los dientes.

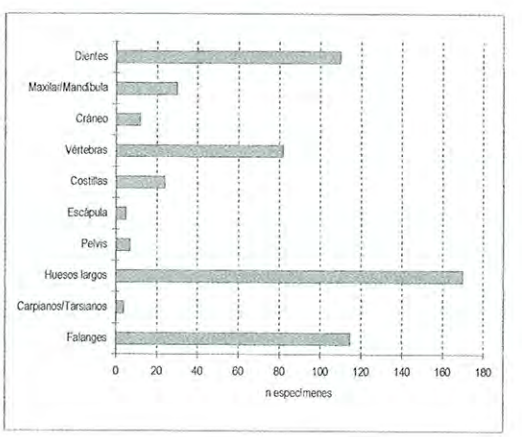

FIGURA 6

Frecuencias anatómicas de taxones pequeños (sumando todos los conjuntos). *Nota*: Sólo un fragmento de diente fue identificado para un taxón más grande.

[6] Nótese que para las mismas especies de zorro en Patagonia, Martín (1998) ha observado, en cambio, un predominio de pequeños mamíferos, más precisamente lepóridos. Debe tenerse en cuenta que la dieta de estos cánidos es sumamente variable y plástica, por lo que debe evaluarse en función de las circunstancias ecológicas específicas.

Las falanges, por el contrario, son más abundantes de lo esperado de acuerdo con otros estudios (Andrews, 1990). Esto probablemente se relacione con el hecho de que muchos huesos de las extremidades distales (patas) han quedado protegidos por las garras, piel y pelo (algo también observado por Payne & Munson, 1985).

Tanto la queratina de las garras y uñas como el pelo parecen ser más resistentes a la acción de los ácidos digestivos que el huesoDe hecho, algunos de los excrementos con mayor contenido de pelo presentaron una mejor conservación de los huesos. Además algunos de los especímenes articulados y cubiertos de tejidos fueron remojados y luego separados, y pudo observarse que presentan una menor intensidad de modificaciones que el promedio.

Los dientes también son bastante abundantes y, a diferencia de algunos estudios (ej. Andrews, 1990), muchos se encontraron "articulados" *in situ* (insertos en los alvéolos).

Estos patrones estarían relacionados con la ingestión de las patas y las cabezas sin necesidad de mucha masticación. Comparadas con la región axial, estas partes no sólo son más pequeñas, sino que no tendrían tanto que ofrecer como para estimular una masticación más intensa (Payne & Munson, 1985).

Cabe mencionar también que los huesos largos están representados tanto por epífisis como por diáfisis. Sólo un 0,5% de estos huesos carece de epífisis, y muchas de las diáfisis están representadas por astillas, siendo los cilindros poco comunes. Solamente algunos de los huesos largos más pequeños están completos.

En base a estos patrones, la destrucción o pérdida de especímenes parece estar condicionada no sólo por la resistencia intrínseca diferencial de los elementos esqueléticos, sino también por los patrones de consumo y masticación del depredador, concretamente, por el tamaño corporal de sus presas. Esto último es consistente con lo observado para las faunas transportadas a las madrigueras.

En un nivel más general, los carnívoros tienden a producir un sesgo de las partes craneales de los pequeños mamíferos respecto de las postcraneales, así como contra las partes más distales de las extremidades respecto de las proximales (Andrews, 1990), y una tendencia similar ha sido observada en estas muestras. Debe destacarse que las proporciones aquí registradas son sólo tendencias aproximadas dada la baja resolución de las determinaciones, que implica, entre otras cosas, que los metapodios fueran considerados entre los huesos largos. De todos modos, en tanto que tendencias generales, pueden plantearse como válidas.

En los conjuntos dominados por pequeños mamíferos, el índice de huesos largos por maxilares y dientes es de casi 1, mientras que en un individuo completo de roedor es de 0,42. Es decir, la tendencia mencionada es notoria: si proyectamos este índice, hay más del doble de elementos postcraneales que craneales. Asimismo, hay más de 20 veces más huesos largos que falanges (asumiendo 56 en 7/97/CZ) en comparación con lo esperado en un esqueleto completo (1,30 frente a 0,18 en un roedor), a pesar de la conservación de la parte inferior de las patas por la queratina.

En cuanto al estado general de huesos y dientes, no obstante la fragmentación, éste no es del todo deficiente (Figura 7). Concretamente, un promedio de casi 8%, distribuidos en 7 de los 16 conjuntos, tiene tejidos blandos adheridos. Y un promedio de 17% están articulados, incluyendo aquí los dientes insertos en alvéolos. Dada la fragmentación observada esto puede parecer inconsistente, pero ha sido observado también en otros estudios sobre cánidos (Andrews & Nesbit Evans, 1983). Además, un promedio del 4% de los especímenes, si bien no estaban articulados, fueron hallados en posición anatómica dentro del excremento. Cabe recordar que el pelo contenido en los excrementos, aún cuando puede no corresponder a los animales de los que provienen los huesos recuperados, parece haber actuado como un elemento de protección.

En lo que concierne a las modificaciones por digestión (Figura 7), un pulido superficial, a menudo manifiesto meramente como una superficie brillante, fue identificado en una media del 11% (entre 0% y 40%) de los especímenes, y es muy común en los más pequeños. Muchos menos especímenes (4% en promedio) se presentan redondeados, usualmente a lo largo de bordes rotos, un daño considerado típico de procesos digestivos (Andrews, 1990). En un promedio de casi el 8% la corrosión ha eliminado la capa cortical, y un promedio de algo más del 3% sufrieron este daño en la cara medular. Unos pocos presentan algún área substancialmente afinada, y otros, fundamentalmente huesos largos, tienen la cavidad interna rebajada, luciendo como si hubieran sido ahuecados o "vaciados" (en ambos casos, promedios <1%). Un incisivo de roedor estaba decolorado. La incidencia de perforaciones por la acción química de los ácidos digestivos es asimismo muy

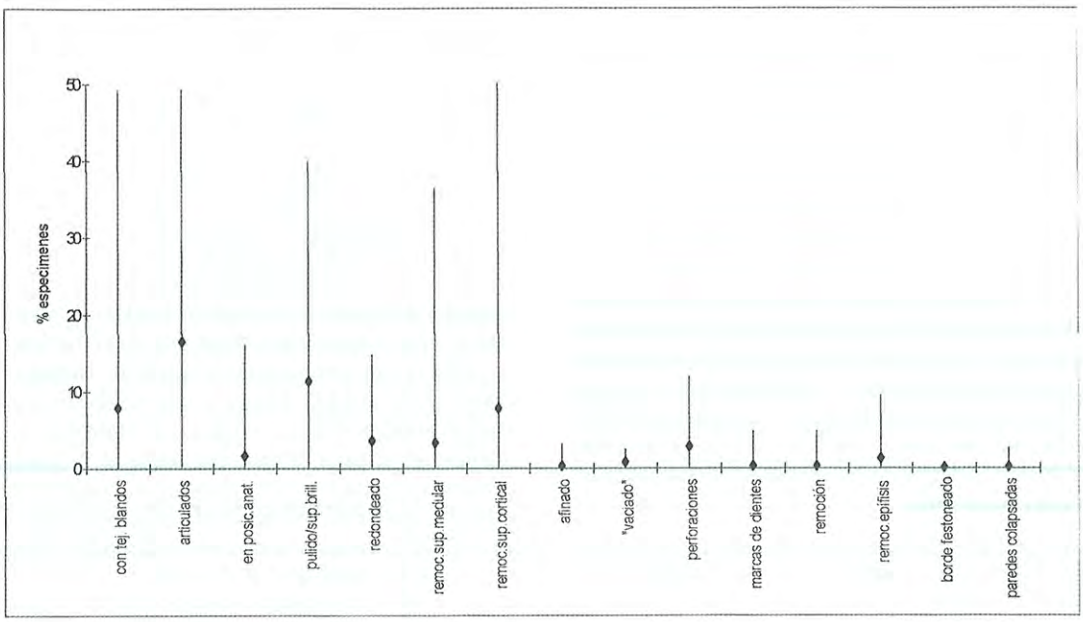

FIGURA 7
Modificaciones óseas: frecuencias máximas, mínimas y promedio.

baja (3% promedio). Finalmente, en el 25% de los conjuntos algunos especímenes simplemente se desintegraron al intentar manipularlos, y esto pudo haber ocurrido en otros sin dejar trazas.

La intensidad de los daños por digestión varía mucho dentro de cada conjunto y entre conjuntos, lo que en parte se debería al pelo y la queratina actuando como protección. Otros factores que pueden incidir son la proximidad de los especímenes a la pared del estómago durante la digestión y el tiempo de digestión, el cual puede estar relacionado con la abundancia de alimento disponible (Mayhew, 1977; Andrews, 1990). También podría haber variaciones a mayor escala, tales como las relacionadas con la disponibilidad estacional de presas, aunque éstas están más allá de los objetivos de este estudio. A diferencia de la fragmentación extrema y el diminuto tamaño de la mayor parte de los especímenes, las modificaciones por digestión no ocurren en frecuencias significativas.

Sólo un espécimen presenta marcas de dientes reconocibles. Esto difiere de lo que Andrews (1990), Stallibrass (1990) y otros han observado: básicamente, que los cánidos son el único grupo de carnívoros que consistentemente deja marcas de mordiscos en los especímenes que han ingerido –aunque incluso en estos estudios hubiera excepciones–.

Otros daños, tales como la remoción de algún área de tejido óseo y los bordes festoneados y paredes colapsadas (todos ellos en proporciones ínfimas: ver Figura 7), no pueden ser atribuidos con certeza a la corrosión digestiva ya que podrían deberse a una atrición mecánica. También se registraron algunos huesos largos sin epífisis, aunque debe recordarse que podría tratarse de elementos no fusionados (no identificados como tales dado su estado), y que se registran tanto epífisis como diáfisis en los conjuntos.

DISCUSIÓN Y CONCLUSIONES

La información generada es consistente en algunos casos, y en otros no tanto, con la que muestran otros estudios sobre conjuntos escatológicos producidos por distintos carnívoros. En general, tiende a corroborar tanto la hipótesis sobre el predominio de los taxones pequeños en los conjuntos analizados, como aquella sobre la importancia de la fragmentación, aunque esta última es aún mayor de lo esperado. A continuación se discuten las implicaciones de estos resultados en función de las líneas de la investigación planteadas al comienzo del trabajo.

Identificabilidad de los conjuntos escatológicos

Respecto de la identificabilidad de los conjuntos escatológicos, es pertinente citar tres factores que Stallibrass (1990) ha distinguido: 1) las posibilidades de que los excrementos de cánido se depositen en niveles arqueológicos, 2) las de que se preserven, y 3) las de que sean 3.a) recuperados y 3.b) identificados. Esta distinción analítica es crucial para comprender los procesos tafonómicos de interés.

En cuanto al primero de estos factores, debe destacarse que es muy común que los zorros depositen sus excrementos en las mismas localidades ocupadas por humanos, especialmente en abrigos rocosos, un recurso altamente valorado por ambos. Más aún, los zorros son depredadores comensales y suelen ir detrás de las ocupaciones humanas en busca de carroña.

Andrews (1990) ha observado que por lo general los depredadores mamíferos, y particularmente los cánidos, producen un daño tan intenso en los huesos ingeridos que no podrían generar contribuciones significativas de pequeños mamíferos en el registro fósil. Sin embargo los estudios aquí presentados sugieren que los zorros pueden llegar a acumular muchos excrementos y, cuando esto ocurre, substanciales cantidades de especímenes esqueléticos. Si proyectamos las frecuencias en las muestras analizadas (tamaño promedio de los conjuntos por cantidad de excrementos en cada abrigo), deberíamos esperar entre 700 y más de 62.200 especímenes por abrigo. Sin embargo no podemos realizar sucesivas interpretaciones sin considerar los restantes factores.

En cuanto a las posibilidades de conservación de los excrementos, éstas son relativamente altas en el árido ambiente puneño, tal como lo atestiguan los excrementos recuperados en los sitios arqueológicos. Este excepcional ambiente de conservación ciertamente ayudará a estudiar la incidencia de los zorros en la formación del registro arqueológico y su integridad.

En caso de que la matriz de los excrementos se desintegre, muchos especímenes, particularmente los fragmentos más pequeños y dañados, podrían estar demasiado debilitados como para sobrevivir procesos atricionales posteriores. Es decir, puede esperarse que sobrevivan particularmente los más identificables anatómica y taxonómicamente, pero no necesariamente los más diagnósticos del proceso de digestión.

Si consideramos la tendencia a una corrosión diferencial de especímenes de acuerdo con la abundancia de pelo y el hecho de que la matriz de los excrementos con más pelo tiende a ser más resistente, puede esperarse que los excrementos más frágiles sean los que porten los especímenes más dañados. Esto acentuaría el patrón recién descrito.

La recuperación de excrementos de contextos arqueológicos no debería presentar inconvenientes. Pero, nuevamente, en caso de que éstos se desintegraran, la recolección de los huesos y dientes derivados sería altamente dependiente de los métodos de recuperación implementados. En realidad, los especímenes más pequeños, de conservarse, sólo serían recuperables a través de métodos como el de cribado húmedo, que implican una malla extrafina. Estos métodos, sin embargo, no siempre se utilizan en la arqueología de la Puna. Son nuevamente los especímenes más grandes los que más probabilidad tienen de ser recuperados, pero debe recordarse que estos constituyen sólo una pequeña proporción de los conjuntos escatológicos, y no necesariamente la que tiene las trazas más diagnósticas de digestión.

Desde que Payne (1972) demostrara la importancia de los sesgos de recuperación en las colecciones recolectadas a mano, muchas excavaciones arqueológicas han utilizado el cribado de modo sistemático. Sin embargo, la relación entre los pequeños fragmentos óseos así recuperados y las actividades humanas en el pasado o cualquier otro proceso de formación del registro arqueológico no ha recibido aún suficiente atención (Stallibrass, 1990).

Además, si bien los excrementos en sí muchas veces han sido recuperados durante los trabajos arqueológicos en la Puna, aún no han sido estudiados sistemáticamente.

Como consecuencia de estas limitaciones, podemos haber subestimado la intervención de los zorros como agentes tafonómicos en los registros arqueológicos de la región, particularmente en relación con los taxones pequeños, y sus implicaciones.

Sesgos de recuperación como el que se menciona arriba condicionan la identificabilidad de los procesos tafonómicos considerados. Las modificaciones por digestión, particularmente el pulido y redondeado de especímenes, son comúnmente consideradas como uno de los criterios más diagnósticos. En su estudio comparativo, Andrews & Nesbit Evans (1983) concluyeron que los conjuntos escatológicos de cánidos son los más fácilmente reconocibles, precisamente debido al intenso daño que caracteriza a dichos huesos. Pero los zorros aquí

estudiados parecen producir bajas frecuencias de especímenes modificados por digestión[7].

Incluso el pulido de superficies, uno de los rasgos más comunes en estas muestras, es bastante raro y suele ser muy sutil, siendo por sí mismo un criterio ambiguo. Además, se produce principalmente en los fragmentos más pequeños que son los que menos opciones tienen de preservarse y ser recuperados, y donde puede resultar más ambiguo. En efecto, uno de los criterios para distinguir las modificaciones por digestión de la abrasión física es que aquella esté bien localizada (Mayhew, 1977), pero en especímenes tan pequeños estos daños necesariamente cubren todo el área, aunque, a diferencia de la corrosión sedimentaria, puede esperarse que sólo afecten a los especímenes suficientemente pequeños como para poder ser ingeridos (Payne & Munson, 1985). Esta línea de evidencia debe por lo tanto manejarse con precaución. Además, la ausencia de mordiscos complica aún más esta situación.

Otras características de estos conjuntos son más consistentes con las mencionadas en otros estudios, con la posible excepción de la fragmentación que, aunque típica de los excrementos de cánidos, aquí parece ser aún más severa.

La fragmentación extrema es precisamente una de las principales características de estos conjuntos. Una de las principales conclusiones de este estudio es que no sólo la proporción de especímenes fragmentados sino también, y especialmente, el tamaño de los especímenes parecen ser criterios clave, conjuntamente con las modificaciones por digestión, para reconocer el origen escatológico de un conjunto fósil generado por zorros.

Significado de los conjuntos escatológicos

El significado de los conjuntos escatológicos estudiados respecto del registro arqueológico tiene varias facetas. Una de ellas es que la presencia misma de excrementos de carnívoro o de conjuntos óseos derivados de ellos en un registro dado es informativa sobre su integridad general, y esta información es a su vez útil para otras inferencias, tales como aquellas de índole paleoecológica.

Otro aspecto importante se relaciona con el hecho de que los conjuntos acumulados por zorros en abrigos rocosos pueden ser muy diferentes según se trate de partes esqueléticas transportadas a las madrigueras, derivadas de excrementos, o ambas. En relación con esto, es importante destacar que las partes transportadas a las madrigueras parecen reflejar principalmente las actividades de carroñeo de los zorros, mientras que las depositadas en excrementos parecen representar más bien las de caza (ver también Borrero & Martín, 1993).

También son diferentes las implicaciones que ambas clases de conjuntos tienen para la integridad del registro. Es altamente improbable que los conjuntos escatológicos, a diferencia de los transportados a madrigueras (Mondini, 1995a, b), puedan ser confundidos con descarte humano en un sitio arqueológico.

Otra diferencia, y una de las principales conclusiones de este estudio, es que los sesgos que estos conjuntos introducirían en el registro arqueológico son muy probablemente de una importancia relativamente menor, especialmente en lo referido a inferencias económicas sobre las poblaciones humanas.

Sólo estudiando ambas clases de conjuntos, así como las propiedades de los conjuntos acumulados por otros agentes, podremos obtener un cuadro completo de la acción tafonómica de los zorros y de su interacción con las poblaciones humanas.

Para concluir, a partir de las investigaciones realizadas, pueden plantearse una serie de expectativas respecto de este último punto, es decir, los patrones de interacción entre las poblaciones humanas y las de zorros. Estos patrones debieron variar a lo largo del tiempo, dejando huellas diferenciales en el registro arqueológico.

Cabe suponer que durante el Holoceno, a medida que la escala de las poblaciones humanas y de sus basureros, concebibles como mosaicos de alimento carroñeable, aumentó en la Puna, la interacción entre zorros y humanos, dependiente de la densidad, debió intensificarse. Y con la domesticación de camélidos, los zorros, además de carroñear en los basureros, también tuvieron la oportuni-

[7] Debe tenerse en cuenta, una vez más, que los especímenes más diagnósticos, y por ende los que más posibilidades tienen de ser identificados como escatológicos, son precisamente los más pequeños y dañados, y por lo tanto más susceptibles a la no conservación y la no recuperación. De todos modos, éstas son consideraciones relativas, y aún en casos en que se conserven y recuperen, las frecuencias de modificaciones serían bajas.

dad de cazar en los corrales, que pueden ser concebidos como mosaicos de biomasa concentrada en el espacio. También los campos de cultivo pudieron resultar atractivos, no sólo como fuente de alimento vegetal sino también como foco de concentración de roedores. En general, al aumentar el sedentarismo, los roedores debieron volverse más comensales y su densidad debió aumentar alrededor de los asentamientos humanos. En algún punto, ahuyentar y excluir a depredadores como los zorros debió constituir una decisión crítica para las poblaciones humanas y requerir de tácticas específicas, tales como las trampas, quema de arbustos y uso de productos químicos.

Por otra parte, los cambios en las estrategias humanas de preparación de alimentos también debieron influir, al introducir variaciones en la manera en que se presentaban las fuentes de carroñeo. Por ejemplo, el hervido de huesos pudo introducir variabilidad, no sólo por la alteración de sus propiedades intrínsecas sino también porque los contenedores requieren que los huesos sean sistemáticamente fracturados.

Finalmente, cabe mencionar a los otros cánidos que además de los zorros habitan actualmente en la Puna: los perros domésticos (*Canis familiaris*). En el Holoceno tardío los perros se volvieron los carníveros comensales por excelencia, y algunas expectativas sobre su acción tafonómica pueden adelantarse. Si estos cánidos consumían más restos de alimentos humanos, y por ende más taxones grandes, cabe esperar un patrón diferente al observado para los zorros. Específicamente, el material óseo se presentaría más fragmentado y menos identificable en sus excrementos. Esto podría estar acentuado si los huesos sufrían un procesamiento humano previo. Además, la protección del pelo y otros tejidos ya no sería tan importante. Por otra parte, al cohabitar en los asentamientos, la escala en que sesgarían los restos de la subsistencia humana podría ser mayor que en los zorros. Debe tenerse en cuenta, sin embargo, que de acuerdo con algunas investigaciones sobre perros cabe esperar una enorme variabilidad en su acción tafonómica (Lyon, 1970; Binford & Bertram, 1977; Binford, 1981; Brain, 1981; Kent, 1981; Hudson, 1993). Estos temas serán precisamente objeto de próximos estudios.

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Cave Bears from Southern Germany: Sex Ratios and Age Structure. A Contribution Towards a Better Understanding of the Palaeobiology of *Ursus spelaeus*

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ABSTRACT: Sex ratios of cave bears (*Ursus spelaeus* and *U. deningeri*) are known to vary greatly between sites. A number of explanations have been proposed to account for this variability, involving for example cave size, altitude, and the seasonality of food availability. This contribution presents demographic data from three sites in southern Germany which allow the rejection of these models; the factor(s) behind the variability in sex ratios is (are) still unknown. The data also suggest that, contrary to the case in living brown bears (*U. arctos*), males in cave bears may have reached a very old age more frequently than females.

KEYWORDS: CAVE BEAR, SEX RATIOS, AGEING, DEMOGRAPHY, SEXUAL DIMORPHISM

RESUMEN: La proporción de machos y hembras de osos de las cavernas (*Ursus spelaeus* y *U. deningeri*) varía de gran manera entre diferentes localidades. Algunos modelos, que incluyen factores como el tamaño y la altura sobre el nivel del mar de las cuevas, así como la estacionalidad de los alimentos disponibles, han sido propuestos para explicar esta variación. Sin embargo, datos demográficos de tres sitios en el sur de Alemania, expuestos en el presente artículo, permiten el rechazo de estas hipótesis. Los factores que contribuyeron en la determinación de las proporciones de ambos sexos son todavía desconocidos. Los datos sugieren también que, a diferencia de lo que ocurre en el oso pardo actual (*U. arctos*), los machos de *U. spelaeus* alcanzaban una edad muy avanzada más frecuentemente que las hembras.

PALABRAS CLAVE: OSO DE LAS CAVERNAS, PROPORCIÓN DE SEXOS, EDAD, DEMOGRAFÍA, DIMORFISMO SEXUAL

INTRODUCTION

The Late Pleistocene cave bear (*U. spelaeus*) is among the most common and most intensively studied of all fossil mammals. The vast numbers of its remains in European caves have enabled scholars to obtain a fairly complete picture of its geographical distribution, anatomy, evolution, and pathology (e.g., Fraas, 1862; Abel, 1931; Breuer, 1931; Ehrenberg, 1931, 1935; Koby, 1949; Kurtén, 1955a, 1955b, 1957, 1959, 1976; Musil, 1965; Cuggiani, 1981; Rabeder, 1983, 1991, 1999; Torres Pérez-Hidalgo *et al.*, 1991; Groiss, 1994; Grandal-D'Anglade & Vidal Romaní, 1997). Nevertheless, in spite of the wealth of its remains, many important aspects of its palaeobiology remain poorly understood. Which factors delimited the geographical distribution of the cave bear? Why did this species, in contrast to its cousin the brown bear (*U. arctos*), go extinct at the end of the Pleistocene? Even the long-held belief that *U. spelaeus* was exclusively vegetarian must now be

apparently questioned (Hildebrand *et al.*, 1996; but see Bocherens *et al.*, 1994 and Fernández Mosquera, 1998).

The fact that *U. arctos* survived the last glacial whereas *U. spelaeus* did not, points to the existence of important differences in the palaeobiology and palaeoecology of these two species. Thus, while for some purposes some physiological characteristics of the brown bear can (or, lacking any alternatives, rather *must*) be considered an approximate guide for the cave bear, e.g., concerning timing of tooth eruption and time of birth, many aspects from their palaeobiology must be deduced from the fossil record itself.

Among the most important characteristics of any mammal population is its demographic structure, since it is determined by both the reproductive biology of the species in question as well as by the interaction of the population with its environment (Kurtén, 1964). Thus, demographic parameters gained from fossil and sub-fossil assemblages, such as age structure and adult sex ratio, can be of considerable importance for the understanding of the palaeobiology and palaeoecology of extinct species.

Many reports on cave bear assemblages describe the demographic characteristics at the site (e.g., Ehrenberg, 1931; Kurtén, 1958; Musil, 1965; Rabeder, 1991; Andrews & Turner, 1992; Grandal-D'Anglade & Vidal Romaní, 1997; Stiner, 1998; Stiner *et al.*, 1998). The interpretation of the age structure in the different sites is often straightforward and convincing (e.g., Kurtén, 1958; Andrews & Turner, 1992; Stiner, 1998). In most cases, juveniles and older adults form the largest part of the assemblages. This can be considered as a clear indication that most individuals died during hibernation (Kurtén, 1958, 1976; Stiner, 1998; Stiner *et al.*, 1998). In contrast, with a few exceptions, sex ratios are only described but not further interpreted. Sex ratios of adult cave bear vary greatly between sites or sometimes even between layers in a single site (Table 1 & Figure 1). At many sites, the sex ratio is approximately even or shows a slight dominance of females (e.g., Yarimburgaz, Odessa, Cotencher, and Dachstein). At others sites, e.g., Saint Brais, Cueva del Toll, Ekain, females clearly outnumber males, whereas males are much more abundant at Arrikrutz and in the upper levels of Mixnitz. In fact the observed variability in the sex ratios is so large that the few interpretations of sex ratios which have been made, usually based in one or a couple of sites, break down when applied to localities other than the ones for which the model was proposed (see below). In other words, if we are to understand this aspect of cave bear palaeobiology, what is needed is an explanation of the *variability* of the sex ratios between different sites rather than different models for each bone assemblage.

This paper should be seen as a contribution towards the understanding of the variability of sex ratios in cave bear. Here, the cave bear remains of three south German sites are investigated: the Bärenhöhle-Hohlenstein and the Sibyllenhöhle in the Swabian Alb and the Zoolithenhöhle in the Frankonian Alb (Figures 2 & 3). The collections from the Bärenhöhle and the Sibyllenhöhle are stored at the State Museum of Natural History in Stuttgart (SMNS). These two caves were excavated in the second half of the 19th century and much of the their fossil material has been subsequently lost. In fact, it has been argued that, due to the selective preservation of the material, adult sex ratios of *U. spelaeus* in these assemblages are so biased as to be completely useless (Adam, quoted in Kurtén, 1976). It can be shown, however, that the sex ratios at these sites are not as distorted by post-excavation factors as Adam suggested; this point is discussed in full in the Appendix.

EXPLAINING THE VARIABILITY OF SEX RATIOS

Since most cave bear assemblages accumulated over a long time span, comprising often thousands of years, it can be discounted that the sex ratios are a product of stochastic processes. Thus palaeobiological/palaeoecological explanations are required.

It must be mentioned that some risk exists that the sex ratios of cave bears in some of the deposits, especially those excavated in the 19th or the first half of the 20th century, in which stratigraphical control is usually poor, may represent an average of changing sex ratios through time. However, due to their recovery methods, these old collections are often quite large, and are thus particularly suitable for biometrical analyses and, consequently, for the calculation of sex ratios. This is a dilemma which cannot be resolved at present; either we use the material we have now and accept the risks involved, or we wait, perhaps for many years, for material with a better stratigraphical control to become available. I have opted for the former.

site	country	sex ratio % (♀:♂)	reference
Arrikrutz	Spain	21 : 79	Torres Perez-Hidalgo et al., 1991
Conturines	Italy	84 : 16	Reisinger & Hohenegger, 1998
Cueva del Toll	Spain	80 : 20	Torres Perez-Hidalgo et al., 1991
Drachenloch	Switzerland	65 : 35	Jequier, 1975
Einhornhöhle	Germany	75 : 25	Schütt, 1968
Eirós*	Spain	58 : 42	Grandal D'Anglade & Vidal Romaní, 1997
Ekain	Spain	71 : 29	Torres Perez-Hidalgo et al., 1991
Hastière	Belgium	40 : 60	Ehrenberg, 1935
Mixnitz, up. levels	Austria	~ 30 : 70	Bachofen-Echt, 1931; Ehrenberg, 1931
Mixnitz, low. levels	Austria	~ 50 : 50	Bachofen-Echt, 1931; Ehrenberg,1931
Odessa	Ukraine	53 : 47	Kurtén, 1955a
Pod hradem 15	Czech R.	42 : 58	Musil, 1965
Pod hradem 12	Czech R.	75 : 25	Musil, 1965
Sima de los huesos+	Spain	~ 77 : 23	García et al., 1997
Troskaeta	Spain	60 : 40	Torres Perez-Hidalgo et al., 1991
Trou de Sureau	Belgium	47 : 63	Ehrenberg, 1935
Westbury+	G. Britain	75 : 25	Bishop, 1982
Wildkirchli	Switzerland	46 : 54	Jequier, 1975
Yarimburgaz+	Turkey	58 : 42	Stiner, 1998

* means of sex ratios from a number of skeletal elements; + *Ursus deningeri*

TABLE 1
Sex ratios of cave bears in some Eurasian sites.

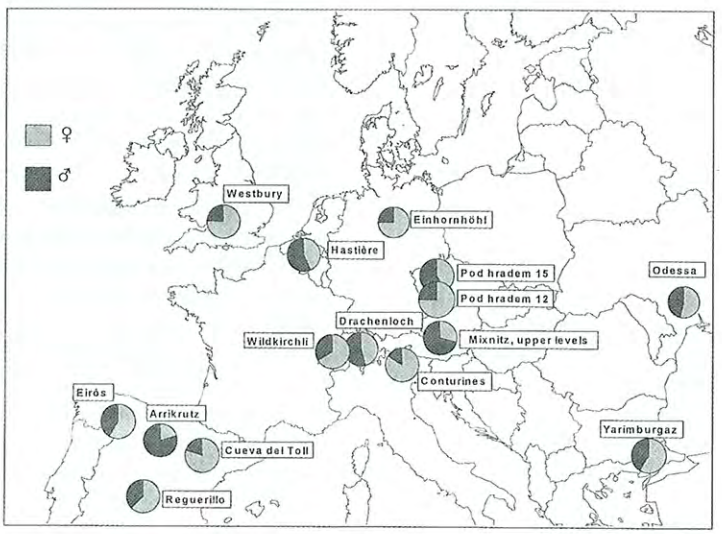

FIGURE 1
Sex ratios in some cave bear assemblages (for data sources see Table 1).

A further complication in the interpretation of sex ratios of cave bear is the lack of data on the demography of those individuals dying in the open; would their sex ratio be complementary to the one observed in the caves in the vicinity? Again, this question must be ignored for the time being but the investigation of the season of death of the few cave bears found in open air sites, e.g. through cementum increment analysis, would certainly help to clarify the issue.

Abel (1929, 1931) arguing from the evidence of the Austrian site of Mixnitz, saw in the clear overrepresentation of males in the upper levels evidence supporting his theory of a degeneration of the cave bear during the Last Glacial culminating in its extinction: a change in the heredity of the species led to a differential birth-rate producing a superabundance of males relative to females. Kurtén (1976) refuted this hypothesis by showing that the sex ratio in Mixnitz was male-biased for the adults only; among the juveniles it was approximately 1:1. Abel's model can also be easily dismissed by the fact that other caves dating like Mixnitz to the later part of the Upper Pleistocene, such as Odessa (Kurtén, 1969), have a female-dominated sex ratio.

Kurtén (1958, 1976) considers an active choice by the bears themselves as the explanation for the variability in the sex ratios. Male brown bears are known to kill and eat cubs and Kurtén assumes that this was the case for cave bears as well. Thus, in order to protect their young, pregnant females or those with cubs would seek small, easily surveyed and defendable shelters where they and their progeny would hibernate. Males, in contrast, were less selective and hibernated also in large caves, even if already occupied by other individuals. According to Kurtén (1958, 1976) it is no coincidence that in the small cave of Saint Brais in Switzerland females outnumber males by as much as 3:1 while in the huge cave of Mixnitz males are more abundant.

FIGURE 2
Location of investigated sites in southern Germany.

A different explanation for the variability of sex ratios was proposed by Reisinger & Hohenegger (1998) in a recent paper on cave bears from three sites in the Eastern Alps. Here, a correlation was suggested between the proportion of females and the altitude of the caves. The authors suggest that female-biased sex ratios in caves in "ecologically extreme areas" (e.g., higher altitudes) are probably a result of the need of females to protect their cubs from male intruders. In the Conturines in northern Italy, located at an altitude of 2,775 m, the proportion of females ranges, according to the skeletal element analysed, from 72%-84%, whereas females in the lower situated cave of Herdengel (780 m) in lower Austria comprise only 13%-54%. In Gamssulzen, intermediate in altitude between the two sites mentioned above (1,300 m), the sex ratio varies from 43%-87% (the differences in sex ratios between different skeletal elements is probably a product of the relatively small sample size; If only the most abundant element at each site is taken into account, the proportion of females are as follows: Conturines 73%, Gamssulzen 84%, and Herdengel 13%).

Yet another explanation of the variability in sex ratios of cave bear was postulated by Stiner *et al.* (1998) in a paper about Middle-Pleistocene cave bears (*U. deningeri*, regarded as *direct* ancestor of *U. spelaeus*) from Yarimburgaz cave in Turkey. It is suggested that the adult sex ratio may be a reflection of the diet of the population in question. In modern bear populations, all pregnant females must hibernate for several months in order to allow the cubs, born during hibernation, to develop. Males and barren females, in contrast, must not hibernate as long as food is available in winter (Stiner *et al.* 1998). The more scarce the food in winter is, the more

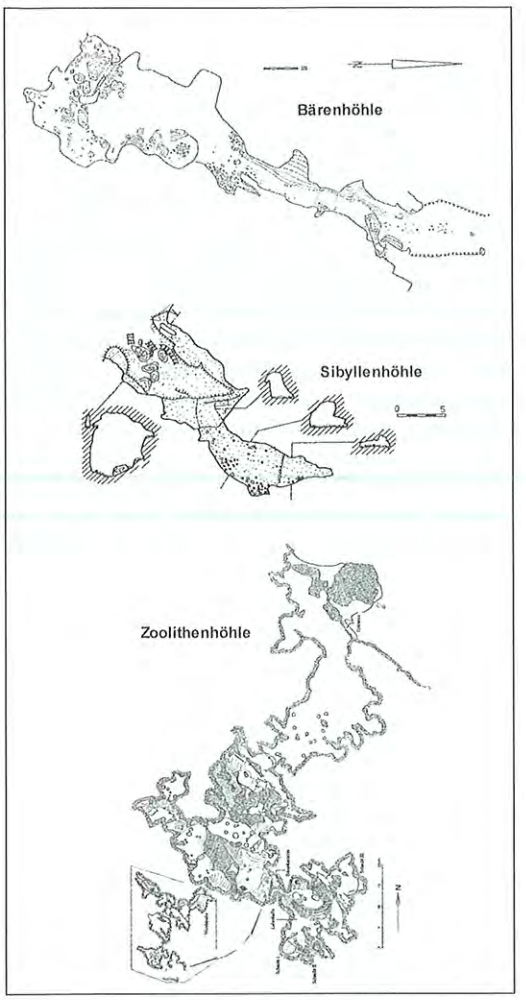

FIGURE 3

Maps of Bärenhöhle (after Schmid, 1989), Sibyllenhöhle (after Bronner, 1979), and Zoolithenhöhle (after Niggemeyer & Schubert, 1972).

males would hibernate, and also die during hibernation within the cave. Thus the sex ratio becomes more even as the food supply becomes more seasonal. From the sex ratio in Yarimburgaz, only slightly skewed towards the females, Stiner *et al.* (1998) deduced that the bear population in this area depended heavily upon highly seasonal resources.

As it will be discussed below, the present investigation of the *U. spelaeus* assemblages from southern Germany allow us to reject at least some of these models.

MATERIAL

The Bärenhöhle

First excavated by O. Fraas in 1861, this cave is located in the limestone cliff outcrop known as the Hohlenstein, on the right bank of the Lone valley (467 m a.s.l.). It consists of a narrow passage, some 1-1.5 m in height and 35 m in length, extending in a N-S direction and giving way to a spacious chamber, which Fraas subdivided into three different chambers, up to 10 m high and some 15 m in diameter (Fraas, 1862; Figure 3).

About 10,000 bones were recovered from the site (Fraas, 1862), from which 98% belonged to *U. spelaeus*. From this amount, 7,000 were considered worth taking back to the Museum in Stuttgart, while the rest was left at the site. During the following years large quantities of material were given away to museums and institutions in Germany and elsewhere, so that today only 3587 fragments are preserved in the collection at the SMNS (see discussion see Appendix).

More recent excavations at the site by Wetzel demonstrated the sporadic occupation of the site by Palaeolithic people during the Mousterian, Aurignacian and Magdalenian (Wetzel, 1961). Thus, the cave bear remains excavated by Fraas, who did not distinguish between layers, span probably some millenia within the last (Würm) glacial. The faunal material from Wetzel's excavations (which was not included in the present investigation) includes *Ursus spelaeus*, *Mammuthus primigenius*, *Coelodonta antiquitatis*, *Equus sp.*, *Crocuta crocuta*, and *Cervus elaphus* (Wetzel, 1961).

The Sibyllenhöhle

The cave, near the city of Kirchheim, is situated at the foot of the rock massif known as the Teck (763 m a.s.l.), on top of which a medieval fortress was built. The site was excavated by E. Fraas in 1898 (E. Fraas, 1899). From its spacious entrance in the NW, the cave runs 23 m to the SE, becoming narrower and lower. Its form can be described basically as consisting on a broad and high forechamber and a broad but low rear chamber interconnected by a narrow passage (Figure 3).

According to E. Fraas (1899), about 10,000 bone fragments were found, from which most were small splinters with rounded edges. About 2,150 fragments were kept, from which 894 are found today in the SMNS collection (for discus-

sion of material lost see Appendix). As in the Bear Cave, more than 95% of the fragments belonged to *Ursus spelaeus*; other species present include lion *Panthera leo*, hyena *Crocuta crocuta*, and horse *Equus* sp. While it is certain that the fauna dates to the last glacial, a more exact chronological position or the time span represented by the accumulation is unavailable. Traces of human occupation were apparently not found at the site.

The Zoolithenhöhle

Located near Burggaillenreuth (470 m a.s.l.) in the Franconian Alb, Bavaria, this site was explored already in the mid-18th century. In contrast to the Bärenhöhle and the Sibyllenhöhle, the architecture of the Zoolithenhöhle is complicated (Figure 3). The entrance is located in the North; from here, a large chamber extends south for about 40 m. Beyond runs a maze of chambers of irregular form, which are often interconnected through narrow, sometimes vertical passages. The cave owes its name to the word, Zooliths, which Esper (1774) coined to denote the remains of extinct mammals he found in the cave. He realized that the vast majority of the finds belonged to bears. According to Heller (1972), the remains of more than 1000 individuals were recovered at the site. It was with faunal remains from this cave that some years later Rosenmüller & Heinroth (1794) described the holotype *Ursus spelaeus*. From the very abundant faunal material from this early investigation, only a small fraction is known to survive nowadays (Heller, 1972; Groiss, personal communication). During 1971, new excavations in a number of different areas which had not been dug or disturbed previously were carried out (Groiss, 1972). This time, again, considerable quantities of faunal material dating to the last glacial were recovered, consisting mostly of *Ursus spelaeus*, but including also other taxa, notably *Gulo gulo*, *Canis lupus*, *Crocuta crocuta*, and *Panthera leo* (Heller, 1972; Groiss, 1979). Absolute radiometric dates from two different locations within the cave range from ca. 29-24 ka BP (Groiss, pers. comm.).

METHODS

Among the Ursidae, males are always larger than females. The difference varies, according to species, between 10-20% to 50% (Stirling, 1993). According to Christiansen (1999), large cave bear males weighted about 400-500 kg whereas females reached "only" 225-250 kg. Since the weight must be supported by the extremities, this size difference is apparent in the width and depth of long bones. A clear sexual dimorphism exists also in the canines (Koby, 1949). Thus osteometrical data can be used to establish the relative proportions of both sexes in an assemblage. In this investigation, measurements were taken with a pair of digital callipers to the nearest 0.1mm following the definitions of von den Driesch (1976) and Grandal-d'Anglade (1993). Included in this investigation were all postcranial limb bones showing fused epiphyses; excluded were phalanges, the smaller carpals and tarsals, and sesamoids. Additionally, the first and second cervical vertebrae, and the lower and upper canines were also measured. The biometrical investigation of the material from the Zoolithenhöhle, while in its end stage, has not been completed yet; thus not all skeletal elements from this site have been included.

The distribution of absolute values in some measurements of postcranial elements shows an overlap between males and females; however, bivariate plots can usually separate between the sexes accurately and absolutely, and can thus used to calculate sex ratios. For each one of the three sites dealt with in this paper, sex ratios were calculated from each of the different postcranial elements and the canines, as long as $n \geq 10$.

It must be stressed that different skeletal elements can, and often do show somewhat varying sex ratios, not only in bears but in ungulates as well (e.g., Grandal-D'Anglade & Vidal Romaní, 1997; Weinstock, 2000, in press; see below). These variations could sometimes be related to sample size but they are also a result of the fact that different skeletal elements represent somewhat different age classes. For example, the canines in living brown bears erupt at an age of ca. 12 months (Dittrich, 1960) and therefore measured canines will reflect sex ratios of animals 1 year and older. There seems to be no data on the timing of the epiphyseal fusion in brown bear (*U. arctos*), but in the black bear (*U. americanus*) the epiphyses of the bones of the forelimb fuse at an age of 6-8 years (Marks & Erickson, 1966). Thus measured humeri or radii with both epiphyses fused would represent the sex ratio of an age group >6 years. This would not matter much if sex ratios in bear populations remained constant throughout all age classes; however, this is not so. In natural-regulated populations of *U. arctos* the sex ratio at birth is roughly equal; however, there is a preponderance of females in all age classes from

sub-adulthood to senescence due to a higher mortality of males, which in turn is a result of males having larger ranges and of their continuing tendency to fight (McNamee, 1997).

In addition to sex ratios, the age structure of the cave bears in each of the three south German caves was analysed. This demographic parameter is relevant for the determination of whether bear mortality occurred mostly during hibernation. Starvation and illness are the main mortality factors during this time, and the corresponding mortality profile is U-shaped, i.e. attritional (Stiner, 1998): young individuals are very well represented, old animals are common, and prime adults rare. In addition to the non-violent mortality factors mentioned above, it is conceivable that hibernating cave bears were also attacked and sometimes killed by conspecifics or other predators such as wolves, hyaenas, lions or humans. If these attacks were frequent, the mortality will resemble more the "living structure" pattern rather than the attritional one, since mortality would affect individuals of all ages equally (Stiner, 1998).

In order to investigate the mortality patterns of the bears of the Bärenhöhle, the Sibyllenhöhle, and the Zoolithenhöhle, a method developed and described by Stiner (1994, 1998) was used. In this method, each tooth is assigned to one of nine different categories or cohorts (I-IX, from young to old) according to its eruption stage and/or its occlusal wear. Stage I, for example, includes all permanent teeth from the germ stage to those with root formation is up to 50% complete. Stage II comprise teeth which are fully (or nearly) erupted, their roots more than 50% complete, but with no visible wear on their occlusal surface. By stage III, some wear of the occlusal enamel is evident but little or no dentine is exposed. At the other extreme, stages VIII and IX include teeth which are very heavily worn, with no or just little enamel remaining in its occlusal surface, and in which the pulp cavities are frequently exposed (Stiner, 1998). These nine cohorts can be pooled into three age stages: juvenile (I-III), prime adult (IV-VII), and old adult (VIII-IX). The relative abundance of specimens in each of the three stages can then be plotted in a ternary (tripolar) graph (Stiner, 1994, 1998). The triangle in this type of graph can be divided into a number of areas, each associated with a mortality pattern family such as the "non-violent attrition" (NNVA) and the "living structure" (LS) patterns (Figure 4).

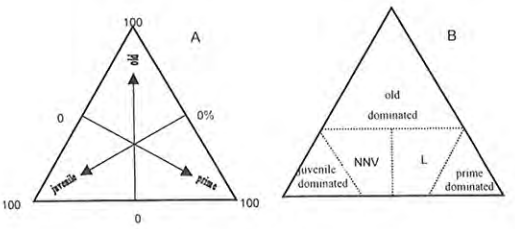

FIGURE 4

Structure of a tripolar age graph (A) and families of mortality patterns (B) (after Stiner, 1990, 1998). The triangle can be divided into different areas, each representing a different mortality pattern. The relative abundance of young, prime adults, and old individuals can throw light on the origins of the thanatocoenose (e.g. death during hibernation, predation, etc.).

In all of the three sites dealt with in this paper mandibles and loose mandibular teeth were much more abundant than maxillaries and maxillar teeth, and therefore the age structure analysis was based only on the former.

Mandibles and loose teeth from individuals in cohorts I and II (i.e. very young animals) are less resistant to mechanical damage than those in older cohorts. Given that the preservation and the recovery methods may differ among sites, the histograms showing the mortality patterns are presented twice in order to facilitate the inter-site comparisons, once including cohorts I and II and once beginning with cohort III.

Stiner's method is definitely an improvement over the traditional four-stage method used frequently (e.g. Musil 1965; Torres Pérez-Hidalgo, 1984; Andrews & Turner, 1992; Grandal D'Anglade, 1993), since it allows a greater resolution, revealing some interesting demographic patterns.

RESULTS

The Bärenhöhle

The sex ratio of adult bears in this cave, as calculated from bivariate plots, varies somewhat according to the skeletal element examined (Table 2; Figure 5). In all elements, however, males are clearly over-represented; they comprise 63-82% (mean ($\bar{x}$) = 73; median ($\tilde{x}$) = 73). A clear majority of males is uncommon, though not unknown, in cave bear assemblages (e.g., Arrikrutz 79%, Mixnitz upper layers 70%; see Table 1).

skeletal element	n ♀	n ♂	% ♀
lower canine	9	20	31,0
atlas	7	23	23,3
axis	5	18	21,7
radius	8	15	34,8
ulna	6	20	23,1
mc II	7	31	18,4
mc III	12	33	26,7
mc IV	8	34	19,0
mc V	20	33	37,7
intermedio-radiale	10	19	34,5
tibia	10	22	31,3
astragalus	13	22	37,1
mt II	6	25	19,3
mt III	12	30	28,6
mt IV	15	57	20,8

TABLE 2

U. spelaeus, number of specimens of male and female and relative abundance of females in the Bärenhöhle.

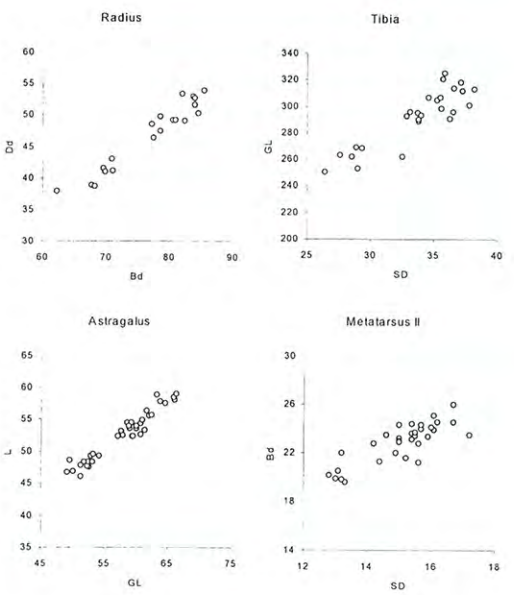

FIGURE 5

U. spelaeus from the Bärenhöhle; bivariate plots of a number of skeletal elements. Two groups, representing males and females respectively, are clearly seen in all plots. In all cases the show an overrepresentation of the former.

Tooth wear and eruption indicate that the many bears at this site died at a very young age (Figure 6 & Table 5). All mandibular molars show a very marked peak at cohort I. Most of the mandibles assigned to this category show an unerupted M_1. Since this tooth erupts during the fifth month of life (Dittrich, 1960), it can be concluded that these individuals died during their first winter. Juvenile mortality (stages I-III) was 75%. Few individuals (ca. 6.5%) died during their prime age (IV-VII), but old adults (VIII-IX) are more common (15-18%). The U-shaped age structure of the Bärenhöhle death population (Figure 6) indicates a non-violent attritional mortality consistent with death during hibernation (Stiner, 1998).

The simultaneous occurrence of the two demographic characteristics of the bear assemblage in the Bärenhöhle, male-dominated and non-violent attritional (winter) mortality, has important implications for the evaluation of the hypothesized relationship (Stiner, 1998) between sex ratios and seasonality of diet.

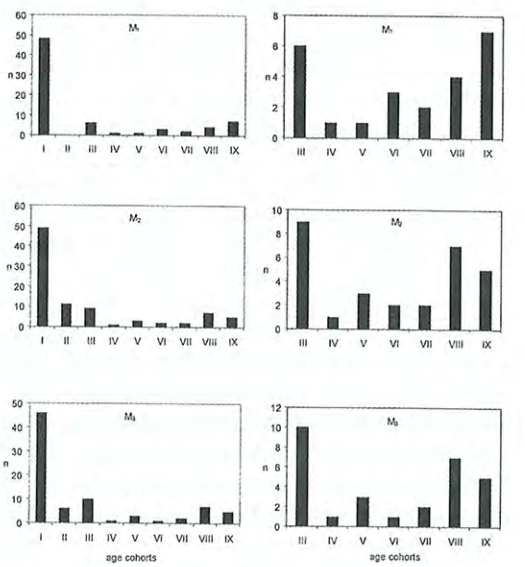

FIGURE 6

Age structure histograms for the Bärenhöhle bear population based on eruption and occlusal wear of mandibular molars. The graphs at the right exclude cohorts I and II, the relative abundance of which could be influenced by taphonomic factors (see text). Neonates (cohort I) dominate in the assemblage; among the older individuals, those in stages III ("young"), and VIII and IX ("old adults") are well represented, while "prime adults" (stages IV-VII) are rare.

site / age cohort	nr. of specimens determined and percentages of total		
	M_1	M_2	M_3
Bärenhöhle	n= 72	n= 89	n= 81
juvenile	75.0	77.5	76.5
prime adult	6.9	6.7	6.2
old adult	18.1	15.7	17.3
Sibyllenhöhle	n=22	n=16	n=13
juvenile	46.2	31.3	50.0
prime adult	46.2	50.0	40.9
old adult	7.7	18.8	9.1
Zoolithenhöhle	n= 103	n= 134	n= 135
juvenile	78.9	86.7	62.2
prime adult	21.1	12.6	37.8
old adult	0.0	0.7	0.0

TABLE 5

U. spelaeus, mortality data from the Bärenhöhle, Sibyllenhöhle, and Zoolithenhöhle for each of the three lower molars. The cohort juvenile includes Stiner's eruption/wear stages I-III, prime adults include stages IV-VII, and old adults stages VIII-IX.

The Sibyllenhöhle

Atlas, scapula, astragalus, and metapodials were present in quantities which enabled the determination of sex ratios of adults (n≥10). While other elements such as humerus, radius, ulna, femur, and tibia are quite abundant (Table 7 in Appendix), most belonged to young animals.

In contrast to the Bärenhöhle, where males comprise about 70% of the adult death population, in the Sibyllenhöhle females outnumber males by as much as 4:1 ($\bar{x} = 77$; $\bar{x} = 80$; Figure 7 & Table 3).

At the Sibyllenhöhle the analysis of the age structure of the bear thanatocoenoses is made somewhat difficult by the small number of mandibles and teeth. The most common dental element, the M_1, is represented by only twenty specimens. It is clear, however, that late-juvenile bears (Stiner's stage III) are abundant (Figure 8 & Table 5). These are individuals which were probably just separated from their mother, and were just beginning to fend for themselves, and perhaps spending their first winter alone. This seems to be a critical transition period in modern brown bear populations which many individuals fail to survive (Bunnel & Tait, 1981). The absence of very young individuals (sta-

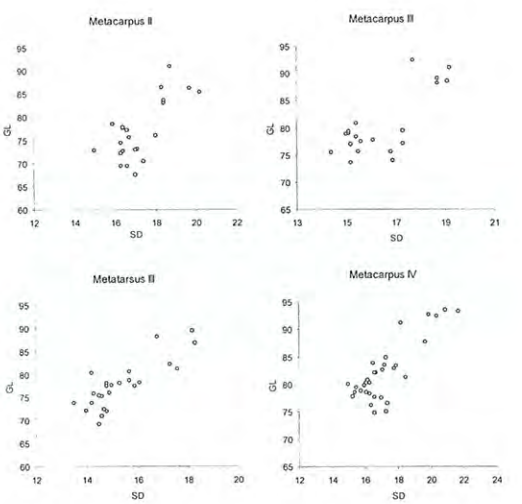

FIGURE 7

U. spelaeus from Sibyllenhöhle; bivariate plots of a number of skeletal elements. In all cases, females, represented by the group of smaller animals, are more abundant than males.

element	E. Fraas, 1899	SMNS collection, 2000
complete skull	7	3
mandible	86	29
loose teeth	652	136
scapula	23	18
humerus	25	18
radius	40	30
ulna	46	44
femur	21	12
tibia	29	24
fibula	19	14
carpals	45	32
tarsals	78	56
metacarpal	213	155
metatarsal	200	139
phalanges	118	75
atlas	26	16
axis	14	8
ribs + vertebrae	249	85

TABLE 7

U. spelaeus, number of specimens from the Sibyllenhöhle recovered and kept by Fraas, 1899 and those present today in the collection of the SMNS.

ges I and II) is conspicuous, but it may be due more to taphonomic than to demographic causes. This is strongly suggested by the analysis of the postcranial skeleton, which includes a relative high number of radii and humeri with early fusing epiphyses still open (Weinstock, unpublished data). The assemblage is also characterized by a scarcity of very old individuals (stages VIII-IX) and a relatively large proportion of prime adults (stages IV-VII). The mortality profile of the M_1 is reminiscent of a "living structure" (LS) pattern, which is not to be expected for denning bears (Kurtén, 1976; Stiner, 1994, 1998). A LS pattern is usually assumed to be produced by a catastrophic mortality or by the sum of discrete hunting events by ambush predators (Stiner, 1994). This would be the expected pattern if, for example, other predators attacked and killed the hibernating bears (Stiner, 1998).

Although about 80 bones (MNI= 4) of the lion *Panthera leo* were found at the site (Fraas, 1899), an unusually large number for a southern German

skeletal element	n ♀	n ♂	%♀
atlas	11	2	84.6
scapula	7	3	70.0
mc II	15	6	71.4
mc III	15	5	75.0
mc IV	26	6	81.2
mc V	16	8	66.6
astragalus	16	4	80.0
mt III	20	5	80.0
mt IV	22	5	81.5

TABLE 3

U. spelaeus, number of specimens of male and females and relative abundance of females in the Sibyllenhöhle.

cave site, it is uncertain whether the accumulation of the bear remains can be ascribed to this predator. It is conceivable that lions attacked hibernating/denning bears, as tigers in the Far East occasionally do (Heptner *et al.*, 1974). However, lions are not usually regarded as denning animals, and it is unclear how their own remains got to be part of the faunal assemblage. Bone remains from the denning hyaena *Crocuta crocuta* were also found in the Sibyllenhöhle, although in smaller numbers (n= 32, MNI= 2; Fraas, 1899).

In short, it is unclear whether the bear assemblage from the Sibyllenhöhle represents mostly individuals which died during hibernation or, rather, primarily from random predation *in situ*. In both cases, however, the sex ratio would be determined by the proportions of males and females which enter the cave before hibernation. The alternatives, that non-hibernating bears were killed by other carnivores and brought into the cave, or that the bear bones in Sibyl's Cave represent scavenged remains of individuals which died somewhere else, are supported neither by the relative common presence of prime adults, certainly not an easy prey for lions, hyenas or wolves, nor by the skeletal representation (Table 7 and Appendix).

The Zoolithenhöhle

Not all of the *Ursus* skeletal elements from this site have been investigated yet, but preliminary results show already a very clear trend concerning sex-ratios. Canines, metapodials, humeri, and radii all indicate that adult and subadult males were very rare at the site (Figure 9 & Table 4). The percentage of females fluctuates, according to skeletal element, between 81% and 96% ($\bar{x} = 90$; $\tilde{x} = 87$).

It must be stressed that, in contrast to the case of the Bärenhöhle and the Sibyllenhöhle, no part of the material retrieved in the 1971 excavations at the Zoolithenhöhle has been subsequently lost. This is important, since it demonstrates that a very biased sex-ratio must not be due to post-excavational taphonomic factors.

element	♀	♂	%♀
upper canine	39	5	86.6
lower canine	27	6	81.8
humerus	39	2	95.0
radius	43	3	93.5
intermedio- radiale	45	10	81.8
astragalus	54	8	87.0
mc II	51	2	96.2
mc III	62	8	87.5
mc IV	42	6	87.5
mc V	55	3	94.8
mt II	47	6	88.6
mt III	46	4	92.0
mt IV	55	2	96.5

TABLE 4

U. spelaeus, number of specimens of male and females and relative abundance of females in the Zoolithenhöhle.

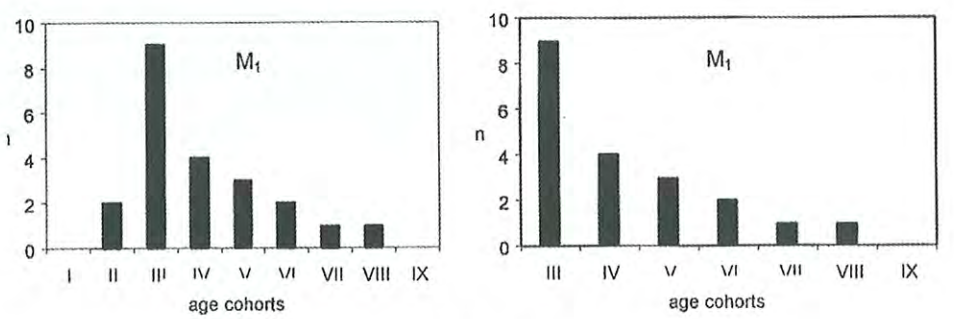

FIGURE 8

Age structure histogram for the Sibyllenhöhle bear population based on the eruption and occlusal wear of M_1 (due to the small number of M2 and M3 available, these were not included in the investigation). The graph at the right exclude cohorts I and II, the relative abundance of which could be influenced by taphonomic factors. Most individuals at this site are "young" (stage III). Prime adults (stages IV-VII) are nevertheless well represented, while "old adults" (stages VIII-IX) are relatively scarce.

The vast amounts of mandibles and dental material present at the Zoolithenhöhle allow for a reliable analysis of the age structure of the bears (Figure 10 & Table 5). Figure 10 shows the relative frequencies of nine age cohorts (Stiner, 1994, 1998) of the three mandibular molars. In these graphs, loose teeth are disregarded; their inclusion, however, leads to identical results. A number of facts are apparent. The distribution is, in contrast to the case of the Bärenhöhle, clearly unimodal peaking at cohort III. As mentioned above, these are probably older juveniles which had just become independent from their mother. Somewhat older individuals (stage IV) are also well represented. Prime adults other than those in stage IV (V-VII) are, on the other hand, very rare. New-born and very young animals (stages I-II) are relatively scarce. Since the fragile mandibles and bones of individuals in these age categories, especially in stage I, are more prone to mechanical destruction than those of older animals, this could have taphonomic rather than behavioural/demographic causes. All in all, juveniles (stages I-III) comprise 62%-87% of the assemblage, depending on which tooth is being analysed. However, the most striking characteristic of the age structure of the cave bears from the Zoolithenhöhle is the almost complete absence of very old individuals (stages VIII-IX). These age classes are usually well represented in other sites regarded as hibernation dens, such as the Bärenhöhle-Hohlenstein (see above) and Yarimburgaz (Stiner, 1998). Rather, the mortality profile from the Zoolithenhöhle resembles more the one from the Sibyllenhöhle (see above), although with a smaller proportion of prime-age adults.

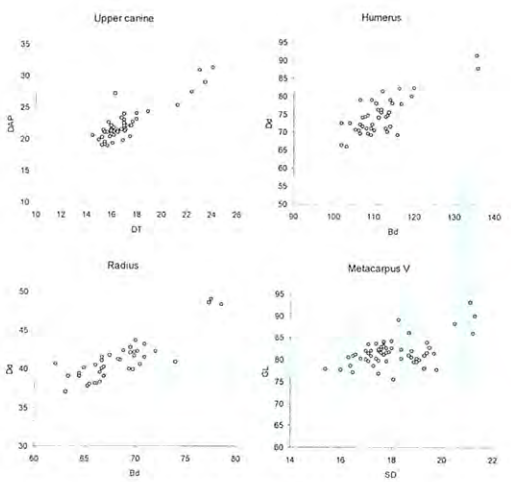

FIGURE 9

U. spelaeus from the Zoolithenhöhle; bivariate plots of a number of skeletal elements. All plots indicate an overwhelming overrepresentation of females.

The interpretation of the sex ratio and age structure of the cave bear assemblage from the Zoolithenhöhle in palaeobiological terms is not straightforward. On the basis of their location beneath a steep ledge, finds from the first (Esper's) excavations at the site were regarded as being remains from individuals which, while roaming around the cave, accidentally tumbled down and either died from the fall or were unable to climb out (Zapfe, 1954; Kurtén, 1976). The more recent excavations show, however, that the taphonomic history of many of the finds is probably more complicated. The large accumulations of bear bones in some parts of the cave are regarded as being caused by water transport (Groiss, 1972). The sources of these accumulations, however, are skeletons of bears which died elsewhere inside the cave (Groiss, 1972). Did most of these bears perish during hibernation? The relatively common presence of mandibles with erupting permanent canines would seem to point in this direction. In *Ursus arctos* the eruption of this tooth takes place between 12-14 months of age (Dittrich, 1960). Since brown bears are born in winter (November to February), these mandibles represent individuals who died during their second winter. Likewise, mandibles with still unerupted M_1 (i.e. younger than 5 months) also suggest winter mortality.

Ideally, if mortality did occur during hibernation, the age-at-death profile should be U-shaped, corresponding to an attritional mortality (Stiner, 1994, 1998). However, as Figure 10 shows, this is not the case. Nevertheless, there seems to be a lack of better alternatives to death during hibernation. While it is conceivable that some bears were attacked by other predators during hibernation, the mortality profile in the Zoolithenhöhle does not take the "living structure" pattern which would be expected in that case.

DISCUSSION

Summing up from the preceding section: the sex ratio at Bärenhöhle is dominated by males; at Sibyllenhöhle females are in the majority; and at Zoolithenhöhle females comprise approx. 90% of the adult thanatocoenose. Furthermore, the cave bears from these sites differ not only in their sex ratios but in their age structure as well.

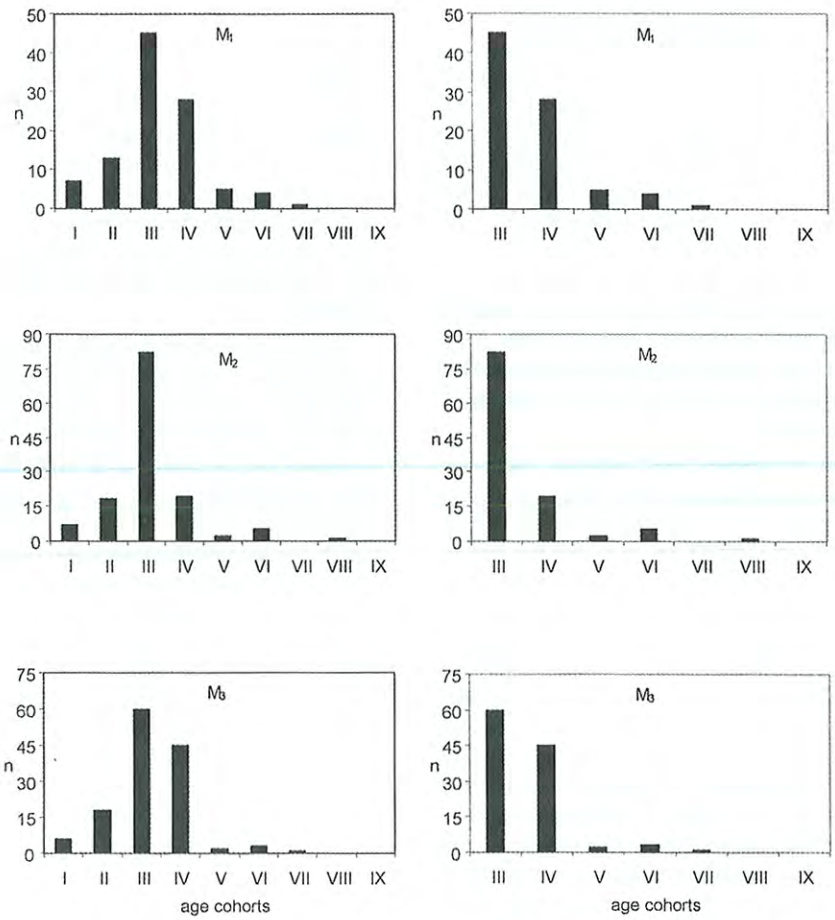

FIGURE 10

Age structure histogram for the Zoolithenhöhle bear population based on eruption and occlusal wear of mandibular molars. The graphs at the right exclude cohorts I and II, the relative abundance of which could be influenced by taphonomic factors. "Young" (stage III) and animals slightly older (Stage IV) comprise most of the population. Neonates (stages I-II) and "prime adults" (stages IV-VII) are very rare, while "old adults" (stages (VIII-IX) are virtually absent.

An interpretation of these differences in palaeobiological terms is not straightforward. Two caves located ca. 60 km apart, the Bärenhöhle and the Sibyllenhöhle, show very different demographic structures. If the model of Stiner *et al.* (1998) of sex ratios as indirect indicators of food seasonality is applied, we would have to conclude that environmental conditions around these two caves differed considerably. Furthermore, the overwhelming representation of females in the Zoolithenhöhle would imply that almost no males were hibernating in the Frankonian Alb. In our opinion, such conclusions are not very plausible. More important is the fact that whereas the paleodiet-model could account for female-biased or even sex ratios, it cannot explain male-dominated bear assemblages such as those from the Bärenhöhle, the upper levels of Mixnitz, or Arrikrutz, since this would imply that males were hibernating in higher numbers than pregnant females! (that the bear assemblage at Bärenhöhle represents indeed deaths which occurred during hibernation is strongly supported by its age structure; see above).

Therefore it can be concluded that, while the proportion of hibernating males and barren females *within a population* may have been affected to some extent by the seasonality of food resources, the sex ratios *within a cave* were determined by other factors.

Moreover, how seasonal the food resources of the cave bear were, is a matter of discussion. Stiner *et al.* (1998) argue that this species depended almost exclusively upon highly seasonal vegetal resources and invertebrates. However, according to recent isotopic investigations, meat contributed as much as 41%-78% of the metabolized carbon and nitrogen in *U. spelaeus* (Hildebrand *et al.* 1996; but see Bocherens *et al.* 1994).

As discussed above, Kurtén (1976) suggested that the variation in the intersite sex ratios could be explained by the size of the caves. Can the differences in the sex ratios between the Bärenhöhle Hohlenstein, Sibyllenhöhle, and the Zoolithenhöhle be thus explained?

In trying to answer this question there are obvious problems. Kurtén (1976) did not specify how cave size is to be measured. Is the area or the length of the cave important, or rather the size of its entrance? If defensibility was the criterion of choice, the existence of a narrow passage and/or small, almost inaccessible, recesses were probably more important than sheer size. The size and spaciousness of the Bärenhöhle and the Sibyllenhöhle is comparable but, as explained above, the sex ratios in these two caves differ markedly. Another cave in the Swabian Alb in southern Germany, the Große Grotte, is basically a spacious chamber, with an entrance 25 m broad. Nevertheless, and contrary to what according to Kurtén's hypothesis could be expected, the high percentage of bones of bear neonates in the assemblage suggests that it may have been mainly females which made use of the cave (Weinstock, 1999).

In any case, even if a relationship between sex ratios and cave properties does not seem to exist, a thorough investigation of this issue would necessarily involve taking into account the changes in topography and sediment deposition which have ocurred at each site since, and also during, the Pleistocene. Such an enterprise is beyond the scope of this paper.

Do the results presented here lend support to the hypothesis of Reisinger & Hohenegger (1998) about females looking for caves at higher elevations? It is obvious that the difference in altitude between the German sites, a couple of hundred meters, is nothing comparable to that recorded in the eastern Alps (see above), and variation in sex ratios caused by this factor is not likely to be observed here. Still, as shown above, sex ratios do vary, and they do it in a way unrelated to altitude: males do dominate the Bärenhöhle (467 m a.s.l.), and females are more common in the higher Sibyllenhöhle (763 m a.s.l.); however, the sex-ratio in the Zoolithenhöhle, which is located at a similar altitude as the Bärenhöhle (470 m a.s.l.), is, as mentioned above, strongly biased towards females. In other words, while it is possible that in the eastern Alps altitude does play a role in the variability of sex ratios, this is clearly not the case for the southern German sites; other factor(s) must be involved.

Are sex ratios perhaps related to differing mortality patterns? The details of the age distributions may differ (compare Figures 6, 8 & 10), but, when plotted on a tripolar diagram of the type proposed by Stiner, the assemblages of both the Bärenhöhle and the Zoolithenhöhle are juvenile-dominated (Figure 11 & Table 5), although their sex ratios are clearly biased towards males and females respectively. The Sibyllenhöhle, another female dominated assemblage, appears to belong to a different family pattern, namely that of a "living structure". Thus, in this broad sense, sex ratios and age structure do not seem to be correlated. However, even if mortality patterns at both Zoolithenhöhle and

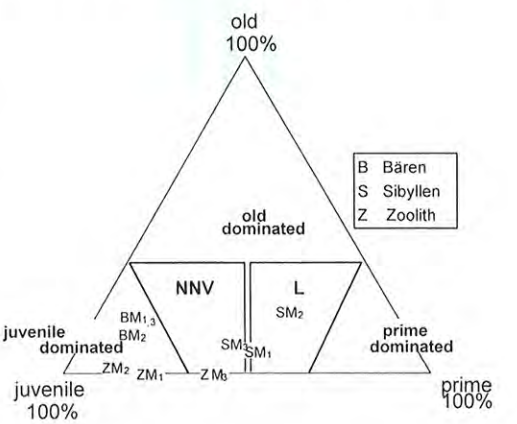

FIGURE 11

Tripolar age graph for the Bärenhöhle, Sibyllenhöhle, and Zoolithenhöhle. The first two sites show a juvenile-dominated mortality pattern, although their sex ratios are very different (male- and female-dominated respectively). The mortality pattern in Sibyllenhöhle falls within the "living structure" (LS) area of the triangle, which according to Stiner (1998) suggests that the assemblage was accumulated by predators such as *Panthera* or *Crocuta*. If ideed the bears at the Sibyllenhöhle were killed by predators, this must have occurred within the cave during hibernation, since the skeletal representation of *Ursus* argues against a transport of dead individuals into the site. Thus, in any case, the sex ratio should reflect the preferences of the bears themselves.

Bärenhöhle are assigned to the juvenile-dominated type, the clear difference in the relative abundance of very old animals between both sites is still in need of an explanation.

In Figure 12, the relative abundance of very old cave bears (stages VIII+IX) from the three sites presented in this study, plus the Brillenhöhle (south-western Germany), and Yarimburgaz (Turkey) is plotted against their respective mean sex ratio. There is a strong inverse correlation between these two variables: as the relative abundance of females in the assemblage increases, the proportional representation of old adults decreases. The interpretation of this pattern in palaeobiological terms is difficult. It seems to indicate that females failed to achieve a very old age as often as males (assuming that very old females had not the "habit" of dying in the open rather than within caves). If this was indeed the case, this would be an unusual demographical phenomenon among Ursids. Apparently, no such phenomenon has been recorded for either brown or black bears (in fact, as mentioned above, the mortality of male *U. arctos* increases relative to that of females from the sub-adult stage onwards; McNamee, 1997). In order to confirm this correlation, the demographic analysis of additional sites is needed. While data on tooth eruption and wear is available from a number of sites (e.g. Musil, 1965; Torres Pérez-Hidalgo, 1984; Andrews & Turner, 1992), the broad, more inclusive age categories incorporated in these cases are not comparable to those of Stiner (1994, 1998), especially for the older individuals.

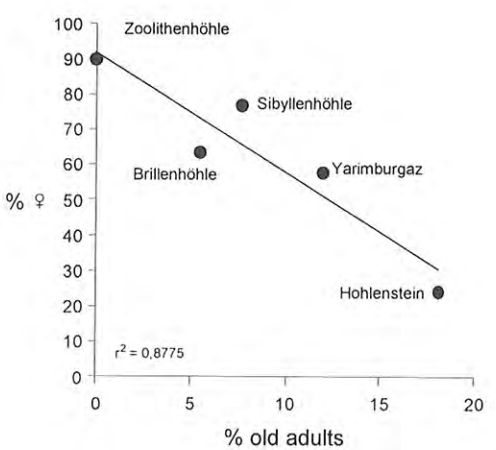

FIGURE 12

Relative abundance of old adult versus abundance of females based on the M_1 (Data for Brillenhöle after Boessneck & von den Driesch, 1973; for Yarimburgaz after Stiner, 1998 and Stiner *et al.*, 1998). A strong inverse correlation is apparent which, if the trend is supported by additional finds in the future, may indicate that males reached an old age more often than females.

The use of tripolar diagrams is certainly useful for the interpretation of mortality patterns of different species (see Stiner, 1990, 1994), but assemblages belonging to the same mortality pattern family (e.g. juvenile-dominated) may still exhibit differences which are a potentially useful source of palaeobiological information.

Summing up, the sex ratios of cave bears in Eurasian sites are highly variable. While the seasonality of the food supplies may have been responsible for the relative frequency of hibernating males within a population, it cannot explain the sex ratios within a cave. In our opinion, Kurtén (1976) was right on varying sex ratios between caves being a product of the choice by the bears themselves. However, it is not apparent that the size of the cave was the criterion according to which the bears choose their hibernation site.

What was the criterion then? We still do not know. Potentially relevant information for recent bear populations is seemenly not available. For European brown bears, caves are not the first choice as denning/hibernation places: only a small minority (ca. 12.7%) uses them for such purpose (Jakubiec, 1993). Whether among these relatively few individuals males and females select different kind of caves remains unknown.

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I would like to thank Th. Rathgeber (Natural History Museum, Stuttgart) for important information about the history of the collections from the Bärenhöhle and the Sibyllenhöhle. I am also grateful to Prof. Th. Groiss (Erlangen) for allowing me to examine the material from the Zoolithenhöhle. Thanks are due to B. Dechert, C. Pasda, K. Pasda, H.-P. Uerpmann, and R. Ziegler who read and commented on earlier versions of the paper.

APPENDIX

The purpose of this appendix is to show that, contrary to the opinion of Adam (quoted in Kurtén, 1964, 1976), sex ratios at Bärenhöhle and Sibyllenhöhle are not a product of their post-excavation history.

element*	O. Fraas, 1862	SMNS collection, 2000
skulls	40	7
mandible	375	152
scapula	100	9
humerus	150	25
radius	130	45
ulna	130	33
femur	200	30
tibia	150	51
fibula	80	24
atlas	90	36
axis	80	25
cervical vertebra	200	120
total	3587	2556

* Fraas (1862) does not present data for elements such as astragalus, calcaneus, carpals, tarsals, phalanges, and vertebrae other than cervical; nevertheless, these elements are present in the SMNS collection.

TABLE 6

U. spelaeus, number of specimens from the Bärenhöhle recovered and kept by Fraas, 1862 and those present today in the collection of the SMNS.

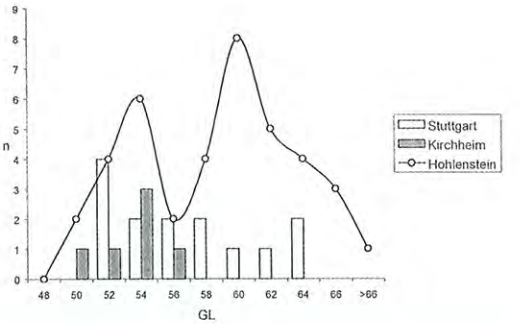

FIGURE 13

Relative frequencies of the greatest length of the astragalus in the material from the Sibyllenhöhle originally stored at the SMNS and in the material returned to Stuttgart from Kirchheim/Teck (see Text). Superimposed is the distribution of the astragali in the Bärenhöhle, which shows a bimodal distribution reflecting the presence of males and females.

Concerning the Bärenhöhle: the statement that O. Fraas excavated the site together with the Swabian Cave Society in 1861 is simply not true, since this Society was only established in 1889 (T. Rathgeber personal communication). It is true, however, that nowadays a considerable proportion of the original material is missing from the collection (Table 6). This is a result of material having been given away to museums, collectors, and researchers in Germany and abroad. An exact record of the material thus lost for the SMNS does not exist, and the selection criteria employed to choose the material being given away are unknown. Nevertheless, it is improbable that those selection criteria, if there were any, were applied so consistently so as to produce an artificial, similar sex ratio in most skeletal elements (Table 2). It seems more probable that the selection had more to do with the state of preservation of the remains, i.e. those specimens being somewhat more damaged were preferentially given away. Fraas (1862) was aware of the clear variation in the size of cave bears from Bärenhöhle; some bones, usually complete humerus, radius, ulna, and femur, were even labelled as belonging to either "Form A" (large) or "Form B" (small). Moreover, he recognized that this large size difference was caused by sexual dimorphism (Fraas, 1862).

In the case of Sibyllenhöhle, it can be clearly demonstrated that the sex ratios are not a result of the material having being divided between the Museum and the Swabian Cave Society, as Adam (quoted in Kurtén, 1976) asserted. After the dissolution of the Society in the first years of the twentieth century, most of its material from the Sibyllenhöhle was deposited at the local museum in Kirchheim/Teck. In the second half of the twentieth century most of these remains were transferred to the SMNS. To be sure, some part of the original material is still missing, mainly skulls, mandibles, teeth, and femora which are easily recognizable for the amateur and the layman and thus more attractive, and it is probable that they remained in the private collections of the Society's members (Table 7).

Since the material returned to the SMNS was kept separate from that originally stored there at the turn of the century, the hypothesis that the Swabian Cave Society got most of the male specimens can be easily tested. As Figure 13 shows, the astragali originally kept by the Society and subsequently returned to the SMNS are of small size. When compared to the distribution at Bärenhöhle, which is distinctly bimodal, it is clear that most if not all of the astragali from Kirchheim/Teck must come from females.

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DRAUGHT CATTLE: THEIR OSTEOLOGICAL IDENTIFICATION AND HISTORY. *Annalen Zoölogische Wetenschappen / Annales Sciences Zoologiques* Vol. 281. Koninklijk Museum voor Midden-Afrika, Tervuren, België / Musée Royal de l'Afrique Centrale, Tervuren, Belgique. ISBN 90-75894-20-1. (Soft cover; 147 pp. Including 94 figures; 1200 Belgian Francs from the Publication Service, Royal Museum of Central Africa, 3080 Tervuren, Belgium). *László Bartosiewicz, Wim van Neer, & An Lentacker* with a contribution by *Marian Fabis* 1997.

Until recently the systematic investigation of osteological evidence for paleopathologies in non-human animals has languished. Studies have been scattered through the literature and buried in the reports of specific archaeozoological collections. Important work has been done, but there have been only a few attempts to systematize our understanding of morphological abnormalities in the bones of different animal forms. One outstanding problem has been matching etiology with specific osteological manifestations. This can be done only, if at all, through the detailed study of well-documented modern cases, and still, equifinality is a constant problem.

Recognizing that "Archaeozoologists usually lack a sound data-base for the description and identification of pathology" (p. 11), Bartiosiewicz *et al.* set out to rectify the situation for the extremities of draught (American: "draft") cattle. Their contribution is divided into twelve parts: 1) Introduction, 2) Material, 3) Methods, 4) Components of draught exploitation, 5) Description and interpretation of the macromorphological deformations, 6) Osteometrical analysis, 7) Internal bone structure, 8) Hoofs and shoeing, 9) Aspects relevant to culture history, 10) Conclusions, 11) Bibliography, and 12) Appendix.

The centerpiece of the monograph is Part 5 with its series of 22 illustrations (Figures 19-40) comprising 70 beautifully produced and reproduced photographs of cattle metapodials and phalanges showing differing degrees of pathological or sub-pathological deformation of those bones. The specimens depicted all come from a collection made in Rumania in the autumn and winter 1991. The extremities of 18 draught oxen were assembled from slaughter houses and transported to Belgium, where they are currently housed in the Royal Museum of Central Africa at Tervuren. Life-history information for the animals, in varying degrees of detail depending upon availability, is presented in the Appendix together with a full set of measurements for the extremities. These data, supplemented by metapodial measurements collected from skeletons of Hungarian Gray cattle and crosses housed in the Hungarian Argicultural Museum in Budapest, form the basis for the authors' study. Each of the Rumanian metapodials was evaluated for the following deformations (where possible): proximal exostosis, proximal lipping, distal exostosis, broadening of the distal epiphysis, palmar/plantar depressions, osteoarthritis at the proximal or distal end, transverse striations, fusion of the second metacarpal, and striated facet on the metacarpal. Pathologies were scored on a scale of 1 (normal) to 4 (most extreme), with the same technique used for the phalanges employing a sub-set of the deformations noted for the metapodials. On the basis of the scoring, a pathological index was calculated for each specimen, with the results being displayed as histograms and statistically manipulated for presentation in scatter plots and in tables.

At the end of Part 5, following discussion of factors affecting the degree of deformation and of spavin, the authors apply their techniques to archaeological material from a Roman site at Namur, Belgium. Here they come upon a shortcoming of their approach, namely that pathological indices can only be calculated for complete bones. This is

particularly a problem for metapodials, which usually occur fragmented in archaeofaunal collections. It would seem to this reviewer that comparing simple percentages of degree of expression of the different deformations for each skeletal part might be a way around this problem.

From qualitative scoring in Part 5, the authors move to quantitative analysis of measurement data in Part 6. Employing standard statistical and graphic approaches (discussed in Part 3), they examine age and sex related variability in cattle extremities. The relationship between the two Parts (5 and 6) lies in the effects that bone apposition due to traction stress has on element dimensions. What is not clear either in Part 3 or Part 6, however, is the degree to which extreme pathologies are reflected in the dimensions reported. Most analysts note when a dimension appears to be affected by pathology; unfortunately this was not done in the Appendix.

In addition, a further point needs to be made in relation to work on modern specimens and to Part 6 in particular. While it may be possible to identify statistical correlation between demographic attributes and bone measurements for specimens of known age and sex, to work the other way using archaeological materials is problematical. Each ancient specimen came from an individual of a particular sex and age at death. To identify the sex and age of that specimen, however, may be impossible. Instead one is often left with a cloud of points on a scatter plot, the interpretation of which is not necessarily straightforward. The importance of studies such as the current one is that they give us models that are potentially useful for interpretation of populations of archaeological data even if the demographic status of the individual specimen cannot be ascertained.

A laudable feature of the current study is the biological discussion that accompanies the data and their interpretation. Of particular value is the presentation in Part 4 that discusses the different factors that might affect the manifestation of morphological changes in extremities of draught animals (loading, harnessing, terrain, shoeing, duration and frequency of work, speed, and team size). In addition the short part (7) on internal bone structure provides important insights into the effects that traction may have on Haversian systems. The study by Marian Fabis draws on previous work carried out by Paaver and others, much of which is unknown to Western scholars because it is published in Russian or in rarely accessed Eastern European journals. At the same time, however, references to Western literature on bone microstructure and biomechanics seem dated. There is considerable scope for further research in this domain.

Draught Cattle is beautifully produced and extremely well edited. The soft cover and the binding seem durable. Even though the book is printed on glossy paper and contains a large number of excellent photographs, it is very reasonably priced. The authors are to be congratulated on the production of a fine piece of work that not only should be on the bookshelf but should be used by every archaeozoologist who studies animal bones from sites where draught cattle are likely to have been employed. This study can also serve as a model for those future studies that can be expected from members of the newly formed Veterinary Paleopathology Working Group of the International Council for Archaeozoology.

RICHARD H. MEADOW: *Zooarchaeology Laboratory. Peabody Museum of Archaeology and Ethnology, Harvard University. U.S.A.*

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