EVOLUTION OF PREHISTORIC FISHING IN THE NILE VALLEY¹

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Abstract

The available data are reviewed on ichthyofaunas from prehistoric sites along the Nile in Egypt and Sudanese Nubia. Former fishing practices are reconstructed using information derived from species spectra, reconstructed fish sizes, growth increment analysis and fishing implements. It is demonstrated that fishing was initially practised exclusively on the floodplain and that it was limited to a small number of shallow water taxa during Late Palaeolithic times. From the Epipalaeolithic onwards (ca 10000-8000 bp), fishing was also undertaken in the main Nile whereby the number of exploited species increased. Technological innovations allowing the exploitation of the deeper parts of the main river included nets and fish-hooks as well as improved vessels, permitting the capture of larger species from the open water. It is argued that fish must always have been a staple food because the animals seasonally occurring in large numbers on the floodplain were intensively exploited and because these fish could be easily dried for future consumption. Once the fishing grounds also included the main river, fishing was no longer restricted to the flood season, but could also be carried out when the Nile levels were low. Hence the role of fish in the resource scheduling also changed at the transition of Late Palaeolithic to Epipalaeolithic times.

Keywords: fish, Late Palaeolithic, Epipalaeolithic, Predynastic, fishing techniques, curing, seasonality.

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Résumé

La présente contribution livre une synthèse des données ichthyofauniques disponibles pour les sites préhistoriques le long du Nil égyptien et nubien. Les pratiques de pêche sont reconstituées sur base des spectres fauniques, de la taille des poissons capturés, des analyses squelettochronologiques et des engins de pêche. Il apparaît que, pendant le Paléolithique supérieur, la pêche était exclusivement pratiquée dans la plaine alluviale et qu'elle se limitait à quelques espèces, typiques d'eaux peu profondes. A partir de l'Epipaléolithique (vers 10000 – 8000 bp), la zone de pêche a été étendue au lit mineur du Nil, ce qui se traduit par une augmentation du nombre d'espèces exploitées. C'est grâce aux innovations technologiques, tels les filets et les hameçons, ainsi qu'à l'utilisation d'embarcations plus performantes, que la capture des grandes espèces des eaux ouvertes est devenue possible à cette période. On suppose que les poissons ont toujours fait partie de la nourriture de base. Ces animaux, très abondants dans la plaine alluviale pendant les inondations, étaient facilement exploitables et se prêtaient aussi très bien au séchage. Dès le moment où les activités de pêche se sont également exercées dans le fleuve même, la pêche n'était plus limitée à la saison des inondations, mais pouvait aussi être pratiquée pendant la période des eaux basses. De ce fait, le rôle du poisson dans l'approvisionnement à travers les saisons a également changé à la transition du Paléolithique supérieur et de l'Epipaléolithique.

¹ This paper is dedicated to Achilles Gautier (University of Gent, Belgium). I thank him for encouraging me to work on fish remains and for the fruitful collaboration since more than 20 years.

Archaeo-ichthyological work in the Nile Valley

The analysis of fish remains from prehistoric sites in the Nile Valley has a relatively long tradition and was initiated in the 1960's by Dr Humphrey Greenwood from the British Museum of Natural History (GREENWOOD 1968). The studied material was excavated in Nubia by the Combined Prehistoric Expedition at the occasion of the rescue operations prior to the construction of the High Dam at Aswan (WENDORF 1968). At that time, the British Museum of Natural History was the only institute with a representative collection of dry fish skeletons from the Nile; these had been prepared mainly by Dr Greenwood to aid in his studies of Quaternary and Tertiary fish fossils (*e.g.*, GREENWOOD 1959, 1972, 1974). His main interests in studying these fish fossils were the zoogeographical and evolutionary aspects, which also explains why he eventually abandoned the analysis of archaeozoological material after exploring the possibilities of several Palaeolithic assemblages (GREENWOOD 1968, 1978; GREENWOOD & TODD 1976). Since the end of the 1970's the fish remains excavated by the Combined Prehistoric Expedition were analysed by the present author (GAUTIER *et al.* 1980; VAN NEER 1986a; GAUTIER & VAN NEER 1989; WENDORF *et al.* 1997) and also Palaeolithic and Neolithic ichthyofaunas collected by several other archaeologists working in the Egyptian part of the Nile Valley (VERMEERSCH *et al.* 1989, 2000, *in press*; MIDANT-REYNES *et al.* 1993; VAN NEER *et al.* 2000; HENDRICKX *et al.* 2001; VAN NEER 1999, 2002). Other researchers that have been working on prehistoric fish remains are Dr Rufus Churcher, who reported on Late Palaeolithic assemblages in Upper Egypt (CHURCHER 1972), and Dr Douglas Brewer, who studied the material from a Neolithic site in the Faiyum (BREWER 1987, 1989) and from a Predynastic site in Upper Egypt (BREWER 1991, 1992). A major contribution to the study of fish remains from Egypt is that by Angela von den Driesch who set up an important reference collection and studied mainly Dynastic sites (BOESSNECK & VON DEN DRIESCH 1982; VON DEN DRIESCH 1983, 1986; BOESSNECK 1988; BOESSNECK & VON DEN DRIESCH 1993). However, she also analysed Neolithic ichthyofaunas from Lower Egypt (VON DEN DRIESCH & BOESSNECK 1985; BOESSNECK *et al.* 1989; BOESSNECK & VON DEN DRIESCH 1990). Although other researchers (*e.g.*, IKRAM 2003; ROSSEL 2003) have reported sporadically on Dynastic fish remains, most of the information available to date on consumption refuse from the Pharaonic period goes back to her work. In the more central part of the Sudanese section of the Nile ichthyofaunal analyses have been carried out on sites dating to the Khartoum Mesolithic and Neolithic period by the present

author (VAN NEER 1983, 1986b, 1989a; MARKS *et al.* 1987; GAUTIER 1988a; CANEVA *et al.* 1993) and by Dr Joris PETERS (1991, 1993, 1995). In this contribution the exploitation of Nilotic fish during prehistoric times is reviewed with an emphasis on the Egyptian and Nubian part of the river, for which most data are available.

Compared to Western Europe, relatively few studies have been carried out in the field of comparative osteomorphology that are directly useful to archaeo-ichthyologists working in the Nile Valley. For the major taxa, the general osteology of the skull and sometimes of the postcranial skeleton has been described, but these figures appeared in taxonomic studies and are of restricted use to the fish bone worker since isolated bones are rarely illustrated (for references see VAN NEER 1984). Some characteristic bones of a few frequent Nilotic taxa have been depicted in BREWER & FRIEDMAN (1989), while VON DEN DRIESCH (*op. cit.*) regularly illustrated diagnostic elements and sometimes elaborated on generic and specific differences among catfishes (BOESSNECK & VON DEN DRIESCH 1982; VON DEN DRIESCH 1983). An osteomorphological study on the dorsal and pectoral fin spines of Nilotic catfishes has been published by GAYET & VAN NEER (1990) and the variability in the skeleton of Nile perch has been described by VAN NEER (1987). An osteometrical study that can aid in the reconstruction of the body size of the same species, starting from the measurements of isolated bones, has also been published (VAN NEER 1989b). A similar study on the metrical relationship between fish length and various measurements of single bones has been carried out recently for tilapia and for *Clarias* catfish (VAN NEER & LESUR 2004), which are the most common taxa at Palaeolithic sites.

Growth ring studies on *Clarias* fin spines from a Neolithic site in the Faiyum (BREWER 1987) and on tilapia otoliths from a Late Palaeolithic site in Upper Egypt (VAN NEER *et al.* 1993) have been used to determine seasonality, and another incremental analysis on Nile perch was aimed at reconstructing changing climatic conditions (BREWER 1992).

Behaviour of the major fish taxa exploited in the past

Although about 70 fish species have been reported from the Lower Nile (BOULENGER 1907; BISHAI & KHALIL 1997), the number of taxa that have been identified in archaeozoological assemblages is much lower and, in the case of the older prehistoric ichthyofaunas, the diversity of exploited fish is very limited

Fig. 1. The major fish taxa that are encountered in archaeological sites along the Egyptian Nile.

(see below). The major fish taxa (Fig. 1) that are encountered in the ichthyofaunas from Egyptian sites are a few catfishes, namely Clariidae (genera *Heterobranchius*, but mainly *Clarias*), *Bagrus* and *Synodontis* species, as well as tilapia (tribe Tilapiini), cyprinids (mainly the large *Barbus bynni*, sometimes *Labeo*) and Nile perch (*Lates niloticus*). The aforementioned taxa, which usually represent more than 90 % of the fish bone finds at the archaeological sites, can be subdivided into two ecological groups, namely "floodplain dwellers" and "open water species". The floodplain dwellers are fish that prefer shallow environments and that can survive in adverse conditions. This group comprises the Clariidae catfish that have accessory breathing organs (so-called respiratory trees on the fourth branchial arches), which enable them to use atmospheric oxygen. The Tilapiini and cyprinids also belong to this group; they do not have accessory respiratory organs, but the haemoglobin of tilapia has the highest affinity for dissolved oxygen, followed by that of *Barbus* (FISH 1956). All these fish spawn in the floodplain and spend an extended period of time in its shallow waters. The "open water species" typically spend most of their life in the main river and include Nile perch and the catfish genera *Bagrus* and *Synodontis*. The Nile perch is a large predatory fish that reaches lengths of up to 2 metres. It is very sensitive to lack of oxygen (FISH 1956) and normally does not enter the floodplain, or only for a very brief time when the floods reach their maximum (COPLEY 1952; JACKSON 1961). Spawning takes place in the main river near the banks from where the larvae migrate towards the floodplain where they undergo their first growth period. Similar behaviour has been reported for

Bagrus, but the case of *Synodontis* is different. These fish enter the floodplain for spawning in large numbers (DAGET & ILLIS 1965), but do not seem to stay in this environment very long. Moreover, more than one *Synodontis* species may have been present and recent studies (LÉVÊQUE 1997) have shown that they differ not only in their ecologies but also in their resistance towards adverse conditions such as fluctuating water and salinity levels, and low oxygen concentrations.

The species targeted, their season and place of capture are to a large extent related to the biology of the fishes, more specifically the seasonal migrations that take place within the river system as a result of rising and lowering water levels throughout the year. Before the construction of the Aswan High Dam, the annual Nile flood started in Egypt in July-August, and it is likely that the behaviour of Nilotic fish was comparable to that observed in other African rivers that still have their natural hydrological regime (WELCOMME 1975). The arrival of the floodwaters, loaded with suspended nutrients, triggers a change in the behaviour of the fish that will soon start spawning (Fig. 2). In the case of *Clarias*, the interval between the influx of floodwaters (in the case of the Nile, coming from the Ethiopian Highlands) and readiness to spawn is only 8-36 hours (BRUTON 1979). As soon as the inundation starts, *Clarias* is the first fish to undertake spawning runs into the shallower parts of the floodplain. Courting and mating takes place in those marginal areas, and it appears that the catfish prefer to deposit their eggs on submerged vegetation, although in the absence of such substrates, they will spawn in pools and on sandy beaches. The depth of waters used for

Fig. 2. Profiles of the Nile Valley (vertical scale exaggerated) showing the fish migrations in relation to the changing water levels throughout the year. Abbreviations for the fish taxa: C: *Clarias*; T: *Tilapia*; B: *Bagrus*; L: *Lates*.

Fig. 3. The Nile Valley and the major archaeological sites considered in this overview.

spawning are always less than 40 cm and usually less than 10 cm. This, combined with the fact that prior to spawning the mouth- and tail-slapping can be heard from several hundreds metres away, and that immediately after mating, the listless catfish lie in groups in water less than 50 cm deep, makes them easy prey. A few hours later, they move back into deeper water (BRUTON 1979). Soon after the *Clarias* spawning, the breeding season of tilapia starts. These are repetitive breeders that can reproduce as long as suitable places are available on the floodplain. All three species living in the section of the Nile considered here make very conspicuous, hollow, nests of circular outline with a diameter of about 25 cm in *Tilapia zillii* and a meter or more in *Oreochromis niloticus* (BALARIN 1979). Parental care is observed in *Oreochromis niloticus* and *Sarotherodon galilaeus* and consists of mouthbrooding that lasts for 10-20 days after which the fry are released. In *T. zillii* the eggs are deposited on a substrate, but the female cares for both eggs and fry. In Lake Sibaya, *Oreochromis mossambicus* breeds in water less than 50 cm

deep but also as deep as 8.5 m (BRUTON & BOLTT 1975). The reproductive behaviour and the shallow habitats in which the tilapia breed also make them very vulnerable to predation by man and animal. *Barbus bynni* also typically spawns at the beginning of the flood season (ABD EL RAHMAN & EL MOHRABY 1984), but details on its behaviour could not be found.

Once the waters in the floodplain start lowering, the fish will undertake a lateral movement towards the main Nile. In the beginning, it is mainly the adults that move towards the main river, later on more and more juveniles will follow (REIZER 1971). The return towards the main stream happens locally through narrow channels, which are very suitable places for trapping the numerous migrating fish. As the drop in water level continues, the contact with the main channel will be broken and residual pools start forming. The larger ones may continue to exist throughout the whole dry season, until the next floods, but they will become shallower and deoxygenated as a result of evaporation. As

Fig. 4. Relative importance of "floodplain dwellers" (shallow water species) versus "open water species" in Egyptian and Nubian sites dating to the Palaeolithic, Predynastic and Pharaonic period.

these pools become shallower, the fish will become more accessible to predators, including man, and when they ultimately dry up completely all the trapped fish will die by suffocation. With respect to the interpretation of the archaeological finds, it is important to note that the residual ponds will contain mainly juvenile specimens of species that are resistant to low oxygen levels, high water temperatures and salinities.

As already mentioned above, Nile perch and *Bagrus* usually do not enter the floodplain for spawning, which is believed to take place in the main stream, near the river banks from where the fry would migrate towards the floodplain. When the juveniles have undergone their first growth period on the floodplain, they will return to the main channel together with the other fish. It is clear that only small specimens of these open water species can be captured on the floodplain.

During the low water season, access to the main river becomes gradually easier since the turbidity decreases. In principle, all species belonging to the category "floodplain dwellers" can also be caught in the

main Nile, but the most typical catches from the main river are the non-juvenile specimens of the "open water species" *Lates niloticus*, *Bagrus* and *Synodontis*.

Former fishing practices

Information from species abundance and reconstructed sizes

Figure 3 indicates the major sites of which the ichthyofaunas have been considered in this overview. When the species composition of the ichthyofaunas from various periods is compared, it appears that a diachronic trend can be observed. Figure 4 shows the proportions of the floodplain dwellers (clariids, tilapia and cyprinids) versus the open water taxa (Nile perch, *Bagrus* and *Synodontis*) for a single Middle Palaeolithic site in Nubia, for several Late Palaeolithic sites in Nubia and Upper Egypt, for an Epipalaeolithic site in Upper Egypt and one in Nubia, and for five Predynastic sites (4 in Upper, 1 in Lower Egypt). Although more assemblages have been described in the litera-

Fig. 5. Relative importance of clariids, tilapia, cyprinids and eel at various loci at Wadi Kubaniya. Sample sizes are indicated in brackets.

ture, these ichthyofaunas were chosen because of their large sample sizes. The observed trends that are described below remain the same however. In addition to the prehistoric material, the ichthyofauna of a single site dating to the Pharaonic period has been added. It is striking that the Late Palaeolithic fish faunas consist almost exclusively of shallow water species. Within this group of fishes, clariids usually dominate. From the Epipalaeolithic onwards (*ca* 10000-8000 bp), the composition of the ichthyofauna changes drastically: besides species typical of shallow waters, open water taxa now contribute significantly to the fish fauna. The major taxa found are Nile perch and *Synodontis*, *Bagr*us is usually less frequently represented. These data clearly indicate a shift around 10000-8000 bp from almost exclusive fishing in the floodplain towards an exploitation of both floodplain and the main river. No doubt technological innovations must have been involved that allowed the exploitation of the main Nile, including the deeper parts of the river where large Nile perch live preferentially. Instead of fishing from the shore, it must be accepted that it was from now on possible to gain access to more offshore parts of the main Nile, probably because more stable vessels were developed. The Middle Palaeolithic assemblage of the Nubian site 440

(GREENWOOD 1986) differs from the pattern observed in the Late Palaeolithic. *Clarias* preponderates here showing that the floodplain was exploited, but the large Nile perch and *Synodontis* suggest that fishing in the main channel was practised as well. It is suggested that no advanced fishing technology was needed here because of the special geomorphological position of the site, at the mouth of the Second Cataract, which may have allowed easy capture of those fish (GAUTIER & VAN NEER 1989).

The relative importance of the shallow and open water fish within each period is different from site to site and can, in some cases, be related to the physical environment (*e.g.*, extent and morphology of the floodplain) or a seasonal occupation. For instance, the extremely high proportion of open water taxa (93 %) at Elephantine (BOESSNECK & VON DEN DRIESCH 1982) is probably due to the fact that this Dynastic site is located on a granitic island without habitats suitable for clariids or tilapia. At the Predynastic site Mahgar Dendera 2, open water fish represent 89 % and this is seen as a combined effect of the physical setting and of the seasonal use of the site (HENDRICKX *et al.* 2001). This temporary camp was separated from the Nile by a relatively narrow floodplain and to the south of the

Fig. 6. Relative importance of small, medium, large and very large specimens in the clariids and tilapia from various sites at Wadi Kubbania. The size classes were defined as follows for clariids: small (<25 cm SL), medium (25-50 cm SL), large (50-75 cm SL), very large (>75 cm SL). For tilapia the following size categories were retained: small (<15 cm SL), medium (15-30 cm SL), large (30-45 cm SL) and very large (>45 cm SL).

site was a small wadi. The fish, molluscs, migrating birds and the age of the ovicaprids, as well as archaeological data, all point to a seasonal use of the site when the Nile waters were low, possibly extending to the very beginning of the floods. At the time that the wadi, and possibly also the narrow floodplain, became suitable places for fishing clariids and tilapia, the inhabitants of the temporary camp and their flocks

must have left the site to join the main settlement elsewhere along the Nile.

Sometimes, intrasite variability can be observed within the ecological groups defined. This was the case at Late Palaeolithic Wadi Kubbania (VAN NEER 1986a; GAUTIER & VAN NEER 1989) where four loci yielded almost exclusively clariids and small to moderate numbers of eel (*Anguilla anguilla*), whereas three others were characterised by an absence of eels and by high numbers of both clariids and tilapia (Fig. 5). The explanation for these differences becomes evident when the sizes of the clariids and tilapia are considered (Fig. 6). Because of the large number of fish bones, a very simple method of body size reconstruction was carried out by direct comparison with modern skeletons of known length. The fish remains were grouped into four approximate size categories: small, medium, large and very large. The boundaries of the size classes were defined in function of the maximum length that the species normally attain. The size distributions show clearly that the fish from loci E 81-4 and E 82-3 are on average much smaller than those from the other loci, a phenomenon that can be explained as a function of the time and place of capture of the fish. The assemblages E 81-4 and E 82-3 have been attributed to "late sites" whereas the others were defined as "early sites" thereby referring to the period within the year that the fishing and accumulation of remains took place. It was postulated that the remains from the early sites correspond to fish that were mainly captured at the begin-

ning of the floods: this is the period when larger adults are most vulnerable to capture because of their inshore spawning behaviour. The assemblages from the later sites are believed to mainly represent fish that were captured later on during the flood season when residual pools had been formed and when larger individuals had already migrated back to the main river. This hypothesis is confirmed by the occurrence of eel

Fig. 7. Length-frequency distribution of 350 *Oreochromis niloticus* otoliths from Makhadma 4.

at the early sites and its near absence at the late sites. Eels are reputed for their predatory behaviour on eggs and fry, and must have occurred in the shallow waters of the floodplain simultaneously with the spawning catfish and tilapia.

Information from growth ring analysis

In the foregoing paragraphs, it became clear that the species spectrum allows a distinction between floodplain versus main river fishing, and it was also demonstrated that the reconstructed sizes can help to distinguish between fishing early and late within the flood season. Using the results obtained at Wadi Kubbaniya, it was postulated that the ichthyofauna discovered at the Late Palaeolithic site of Makhadma 4 corresponded to fishing activities that took mainly place in residual pools (VERMEERSCH *et al.* 1989; VAN NEER *et al.* 2000). As usual in late Palaeolithic sites, the fish fauna at Makhadma 4 is mainly composed of floodplain dwellers (see Fig. 4) and within this group tilapia predominates. Clariids represent only 30 % of the ichthyofauna and on the basis of their sizes it was supposed that they were captured both at the beginning of the floods and later on in residual ponds. However, in the case of the abundant tilapia remains, no large individuals occurred that would be expected if tilapia fishing also took place at the beginning of the floods. It was therefore postulated that these fish were captured when the floodwaters were receding. The presence of numerous tilapia otoliths at the site allowed verification of this hypothesis (VAN NEER *et al.*

1993; VAN NEER *et al.* 2000). First, the size distribution was analysed of 350 sagittae that could be identified at species level (*Oreochromis niloticus*). The length-frequency distribution (Fig. 7) at first sight looks unimodal, but verification with modern growth data seems to contradict this. *Oreochromis niloticus* in the present-day Chad basin reach a maximum size of 10-11 cm total length (8-9 cm SL) by the end of their first stay in the floodplain where they were born (BLACHE 1964). At the end of the flood season of the following year they reach sizes between 12 and 25 cm total length (about 10-20 cm SL). The tilapia captured at Makhadma 4 thus seem to have been captured in their first and second growth season. The length-frequency distribution of the archaeological otoliths does not show the bimodal trend that is seen in modern catches. This is probably due to the extended period during which young fish were captured at the site year after year and it is also likely that the length of the growing season varied over the successive years of fish exploitation as a result of variation in the amplitude of the floods. The occupation of the site corresponds to the "Wild Nile" stage, when the behaviour of the Nile was irregular (PAULISSEN & VERMEERSCH 1987). A sub-sample of the otoliths was thin-sectioned and the growth increments were analysed in an attempt to further confirm the hypothesis of a seasonal exploitation of tilapia at the end of the flood season (VAN NEER *et al.* 1993). Of the 169 thin-sectioned otoliths, only about 20 % were suitable for analysis. In the other specimens the growth increments could not be followed over a sufficient distance, or they had a dark band at the outer edge of the otolith that made the terminal growth

Fig. 8. Daily growth increments on a *Oreochromis niloticus* otolith from Makhadma 4. The arrow indicates the gradual transition of fast to slow growth.

zone illegible. It is likely that recrystallisation of the aragonite during diagenesis is responsible for these poor preservation conditions. For the thin-sectioned otoliths (**Fig. 8**) it was striking that daily growth increments became visible, and it appeared that zones with narrowly spaced daily growth rings (slow growth) alternated with zones of more widely spaced daily rings (fast growth). The width of daily rings, and growth zones in general, is related to the availability of food and temperature: during their stay on the floodplain an increased growth rate is observed in African fish (JOHNELS 1954; DE MERONA & ECOUTIN 1979). Observation of the marginal area of the 28 well preserved otoliths showed that the last daily rings that were laid down during the animal's lives were widely spaced, indicating that the fish were captured during the inundation. When the number of widely spaced rings was counted from the margin of each otolith towards the point where the transition to slow growth takes place, then it appeared that the fish were captured between 20 and 220 days after the beginning of their stay on the floodplain (**Fig. 9**). Most of them were caught between 40 and 80 days after the inundation started. This growth increment analysis hence confirms that tilapia fishing was limited or non-existent at the beginning of

the floods, but it also shows that the residual pools were exploited for a long period. Probably the topography of the floodplain was such that residual ponds were of considerable size and that they persisted for an extended length of time.

Pectoral spines of clariids have been used for seasonality estimations by BREWER (1987), who succeeded in recognising two fishing seasons within the year at a Neolithic site in the Faiyum. Although the growth increments were interpreted in terms of changing temperatures throughout the year, it is not excluded that the two periods would, instead, correspond to a fishing season when the lake levels rose and a second one when the waters were receding and marginal pools were formed. No such incremental study has been carried out on clariid spines from prehistoric sites in the Nile Valley, apart from an attempt by the present author to analyse the material from Wadi Kubbania. However, preservation of the bone histology at this site was poor and the analysis was abandoned because of the poor quality of the thin-sectioned material. Shortcomings inherent to the method itself were demonstrated on pectoral spines of *Clarias gariepinus* from a historic site in Syria (VAN NEER 1993). It appears that

Fig. 9. Length of the last, rapid, growth phase in classes of 20 days, observed on 28 tilapia otoliths from Makhadma 4. The fluctuations in the Nile level are also indicated.

seasonality is difficult to establish when the season of capture falls outside the period of rapid growth. However, given the success reported for the Faiyum material, it seems worth pursuing this type of research on clariid spines from the Nile Valley.

Information from fishing implements

Small double points, with a round to oval section and typically made of mammal bone, have been found at several Late Palaeolithic sites in Upper Egypt. These fish gorges occur at sites E 78-3, E 78-4 and E 81-1 at Wadi Kubbaniya (GAUTIER & VAN NEER 1989), at Makhadma 4 (VERMEERSCH *et al.* 2000), and at El Abadiya 3 (VERMEERSCH *et al.*, *in press*). To these objects a line is tied in the middle and the bait is attached in such a way that the gorge is parallel to the line (VON BRANDT 1984). When a fish grasps the bait, the gorge takes up a transverse position in the mouth or branchial cavity. Attached to bottom lines, this type of device seems most suitable for luring clariids, which are omnivorous fish with a wide mouth, although it is not excluded that larger tilapia can also be captured with gorges. In that case, the gorges would need to be

attached to rod and line or to drift lines. It is likely that during fishing on the floodplain a wide variety of other techniques were used for which no archaeological indications could be found. During the massive inshore occurrence of spawning fish, grasping by hand, clubbing, spearing and other simple techniques are still used today (BRUTON 1979). During the spawning runs, and also during the return of the fish to the main river, channels could be exploited in various ways, including the techniques mentioned above, and, in addition, dams and fences may have been erected on the channels. In the residual pools fish gorges may still have been laid out, but once the water became wadable, it is likely that less elaborate techniques would have been used. Grasping by hand, wounding and striking gear, and cover pots may have been used, and in addition deoxygenation (by stirring up the mud) and ichthyotoxic plants may have allowed the capture of more the sensitive taxa (mainly tilapia and cyprinids). Fish from smaller residual pools may have been taken with scoop baskets. No clear evidence for nets has been found in the Late Palaeolithic sites thus far.

Once fishing in the main channel started, it is obvious that new fishing techniques must have been

	very large (>75 cm SL)			large (50-75 cm SL)			medium (25-50 cm SL)			small (<25 cm SL)		
	pre-caudal	caudal	sample size	pre-caudal	caudal	sample size	pre-caudal	caudal	sample size	pre-caudal	caudal	sample size
E 78-2	-	-	-	100	0	12	53.6	46.4	28	100	0	1
E 78-3	100	0	5	90.6	9.4	117	69.0	31.0	654	46.7	53.3	15
E 78-4	100	0	6	86.0	14.0	50	71.0	29.0	114	80.0	20.0	5
E 81-1	0	100	1	81.9	18.1	72	51.3	48.7	76	29.0	71.0	31
E 81-4	-	-	-	75.0	25.0	16	50.2	49.8	199	46.2	53.8	39
E 82-3	-	-	-	30.0	70.0	10	44.6	55.4	121	36.4	63.6	11

Tab. 1. Ratio of precaudal and caudal vertebrae in each size class of the Clariidae, observed at various loci of Wadi Kubbania (after VAN NEER 1986).

available. Typical of the Epipalaeolithic and later sites is the dramatic increase in the number of species, which in itself is already a good indicator for the use of nets: this fishing gear is non-selective (apart from the size of the fish which is related to the mesh width). Net weights have only rarely been reported, but it should be kept in mind that sinkers would not necessarily be recognised as such when they were made from stones (BOISSIER 1984). Examples of net sinkers from Predynastic sites are the perforated stone from Mahgar Dendera that was described as a net weight (HENDRICKX *et al.* 2001: 88) and the four spherical net sinkers made of limestone at Adaïma (MIDANT-REYNES & BUCHEZ 2002: 449). Numerous perforated circular objects made from fired clay have been found at the latter site as well (MIDANT-REYNES & BUCHEZ 2001: 437) which may also represent net weights rather than spindle whorls as suggested. At Adaïma, two bone objects were found that have been classified as net needles (MIDANT-REYNES & BUCHEZ 2002: 437). Other fishing gear reported from Predynastic sites are copper hooks found at Adaïma (MIDANT-REYNES *et al.* 1998; MIDANT-REYNES & BUCHEZ 2002: 453) and bone harpoons discovered at Adaïma (NEEDLER 1984; MIDANT-REYNES & BUCHEZ 2002: 437) and Nagada (BAUMGARTEL 1960).

Processing of fish

Due to the predictability of the massive occurrence of spawning fish on the floodplain, tilapia and, especially, *Clarias* have been important commodities since Palaeolithic times. It is likely that a surplus of food was available both at the beginning of the yearly inundation and at the time that residual pools were exploited. The arid climate of Egypt allows relatively easy

preservation of fish by air or smoke drying, a practice that is well documented for the Dynastic period (VAN ELSBERGEN 1997). The ichthyofaunas discovered thus far along the Nile in Egypt and Sudanese Nubia yield only scanty information on this practice during prehistoric times. On the basis of the relatively low proportions of *Clarias* vertebrae it has been suggested in the past that their underrepresentation may be due to decapitation and subsequent removal of fish bodies (GREENWOOD 1968; GAUTIER *et al.* 1980). The iconographic data from the Pharaonic period do not show evidence for this practice and also traditional methods in Africa indicate that catfish is usually dried whole (BLACHE & MITON 1962). Nevertheless, there is archaeozoological information from later (Roman) sites in the Levant showing that beheaded catfish were sometimes traded (LERNAU 1986). Using the abundant fish remains from Wadi Kubbania it was possible to test the hypothesis of decapitation (VAN NEER 1986a; GAUTIER & VAN NEER 1989). These large assemblages indeed indicate that *Clarias* vertebrae are more heavily underrepresented than in any other taxon, and this is a phenomenon seen on most prehistoric sites. For the purpose of this analysis, the proportions of precaudal and caudal vertebrae were indicated separately for each of the four retained size classes (Tab. 1). It is striking that the larger the catfish are, the more dominant the precaudal vertebrae are. The proportion of caudal vertebrae increases with decreasing body length, but the ratio of one precaudal vertebra to three caudals, as in a complete axial skeleton, is never reached. The fact that caudal vertebrae are systematically underrepresented, and more so in the larger size classes, could indicate that man preferentially removed the bodies of the larger fish. If this were indeed the case, then it can be expected that the size distributions

		very large (>75 cm SL)	large (50-75 cm SL)	medium (25-50 cm SL)	small (<25 cm SL)
	sample size (spines)				
E 78-2	69	2.9	24.6	72.5	0.0
E 78-3	1222	0.4	11.8	84.0	3.8
E 78-4	229	0.0	18.3	76.9	4.8
E 81-1	59	3.4	42.4	52.5	1.7
E 81-4	97	0.0	0.0	55.7	44.3
E 82-3	112	0.0	2.7	78.5	18.8
	sample size (vertebrae)				
E 78-2	52	0.0	25.0	73.1	1.9
E 78-3	1088	0.5	11.9	85.8	1.8
E 78-4	309	1.9	18.5	76.7	2.9
E 81-1	202	0.5	39.6	42.6	17.3
E 81-4	314	0.0	5.7	79.0	15.0
E 82-3	189	0.0	6.9	85.2	7.9

Tab. 2. Proportion of the various size classes within the Clariidae from Wadi Kubaniya, calculated separately for the pectoral spines and the vertebrae (after VAN NEER 1986).

obtained for cranial elements would differ significantly from those obtained on the vertebrae: size distributions based on head elements should show an increase of larger specimens compared to the distributions based on vertebrae. *Table 2* shows, however, that this is not the case and that another factor must be responsible for the observed trends. The most likely explanation seems to be differential preservation, since the under-representation of clariid vertebrae is seen at most archaeological sites. Similar low frequencies of catfish vertebrae are also observed at palaeontological sites, where human influence is excluded *a priori* (VAN NEER 1994).

No other patterns in the skeletal distribution seem to occur in the Nilotic sites that could be possibly related to processing of fish, and information in the form of cutmarks is lacking as well. It is likely, however, that fish processing in prehistoric times was comparable to methods used in Pharaonic times (*cf.* VAN ELSBERGEN 1997) and to traditional methods used in Africa today (*cf.* BLACHE & MITON 1962). The efficiency of sun-drying depends on aridity, air temperature and wind velocity, and it is obvious that the Nile Valley is a suitable environment for such activities. Drying is hastened when the surface to volume ratio is high, which explains why fish are sometimes split longitudinally or cut in chunks to increase the ratio. The drying process can be accelerated by heating with fire, or by salting, although the latter method does not seem to have been in use for fish preparation in the Dynastic period. Sun- or smoke-drying can be done on the ground by spreading fish out to dry on sand or on piles of grass.

In the latter case, the grass, that may also cover the fish, can be set alight. An alternative method is to hang up fish or to place them on wooden racks to dry. Again, the drying process can be accelerated by making fire under the suspended fish. The archaeological record of the region under consideration yielded clear evidence for fish smoking in one instance. At the Late Palaeolithic site of Makhadma, dated to about 12000 cal BC, thick midden deposits with abundant fish remains and charcoal were found (VAN NEER *et al.* 2000). The spatial distribution of the finds shows that charcoal and fish bone concentrations occur in a step-like succession of terracettes. Such shallow pits along a slope for fish smoking have been documented ethnographically (BLACHE & MITON 1962). The site also yielded numerous postholes that may be related to racks that were used to suspend the fish.

Fish curing, either by sun- or smoke-drying, allowed the keeping of part of the seasonal catch for later consumption. At the beginning of the drying process flies may have laid their eggs in the still humid flesh, and later on, when the fish continued to dry they became attractive to beetles, especially dermestids (*Dermestes*, *Necrobia*) which are said to be responsible today for losses up to 20-25 % of the initial weight during transport to the market (BLACHE & MITON 1962). Despite the significant loss of fish meat that may have occurred because of infestation with insects, it is likely that this commodity remained an important source of protein during the months succeeding the main fishing season.

Fig. 10. Reconstruction of the resource scheduling in the Nile Valley during Late Palaeolithic times.

The surplus production of Nilotic fish allowed the preservation of fish for local, own consumption, but it may also be an explanation for the fact that fish were exported as a trade item. Finds of Nile fish outside their natural area of distribution have been discovered in almost 50 archaeological sites in the Levant, Anatolia, the Eastern Mediterranean islands and even Italy (VAN NEER & ERVYNCK 2003; VAN NEER *et al.*, 2004). Mainly *Clarias* and Nile perch were exported, but also other taxa such as *Synodontis* and *Bagrus* catfish, tilapia, Mormyridae, Citharinidae and *Distichodus* also sometimes occur. Although the majority of these finds date to historic periods, evidence is available that Nilotic fish were already traded in Late Chalcolithic times (LERNAU 1996).

The importance of fish in the resource scheduling

From the aforementioned data on the seasonal abundance of fish and on the possibilities of curing them for later consumption, it is clear that this food item played an important role in the resource scheduling of the prehistoric inhabitants of the Nile Valley. On

the basis of the seasonal availability of animal resources, it is possible to reconstruct the role of all consumed animals during the Late Palaeolithic in the annual round (GAUTIER 1988b). **Figure 10** gives a modified version of the reconstruction by Gautier (*ibid.*) for the Late Palaeolithic period and **Figure 11** shows the possible resource scheduling during Neolithic times. Fishing for clariids and tilapia peaked at the beginning of the floods and it is likely that fish, if curing was practised, would also have been available during the period that the floodwaters were at their maximum and when the fish that had terminated their spawning were difficult to reach. This would have guaranteed a supply of fish until the next successful fishing season started, this time in the residual ponds that were formed when the Nile waters receded. The length of time during which these pools could be exploited depended on the topography of the floodplain, but again there was mass occurrence of fish that could be cured for future consumption. Since the spawning of floodplain dwellers and the formation of residual ponds was a seasonally recurrent and predictable event, it is likely that many of the excavated Late Palaeolithic sites attracted humans during the good

Fig. 11. Reconstruction of the resource scheduling in the Nile Valley during Neolithic times (domestic animals not indicated).

fishing season and that population densities increased seasonally. During the season of the floods, waterfowl were also abundant and among them were many winter visitors that were also captured for food (GAUTIER 1988b). It is unlikely that the fish cured after the exploitation of the residual pools would last long enough to guarantee a sufficient food supply until the next inundation. It is not excluded that fishing was practised at a small scale in the months prior to the inundation, but good evidence for the capture of fish from the main Nile is not available, except for the Middle Palaeolithic site 440 in Sudanese Nubia. However, evidence for the exploitation of other food resources from the main river is seen in the mollusc remains from Late Palaeolithic sites: some of the species such as the Nile oyster (*Etheria elliptica*), *Caelatura aegyptiaca* and *Mutela nilotica* live only in the main Nile and can be reached most easily when the water levels of the Nile are at their lowest. During these spring and early summer months, people may also have relied more heavily on

the large game that was living in the area. Throughout the Late Palaeolithic, hunting of dorcas gazelle (*Gazella dorcas*), hartebeest (*Alcelaphus buselaphus*) and aurochs (*Bos primigenius*) was practised and, taking the meat yield of these herbivores into account, it is clear that they must have been the major source of meat. Although these species occur in the Nile Valley throughout the year, it is possible that they were more vulnerable to predation by man during the months prior to the inundation. Once the floodplains were dry these flats became accessible again to the large game animals who may have found more fodder here than in the marginal areas to which they were forced to migrate as a result of the floods. It should be borne in mind, however, that the availability of the various animals may have varied from year to year with the intensity of the floods. A study of the Nile levels during dynastic and later times has shown, for instance, that at Aswan, the difference in the Nile level between the extremes, *i.e.* a low flooding resulting in

famine and a high flooding causing destruction of the fields, was in the order of almost 3 m (SEIDLMAYER 2001).

From Epipalaeolithic times onwards, the fishing techniques improved which allowed successful fishing in the main Nile. This increased the number of exploited species, and, even more importantly, it also allowed fish to be used as a food resource for a much longer period of the year. Indeed, fishing in the main river must have taken place outside the flood season, probably when the water levels of the main Nile were relatively low. Only then would the water have been less turbulent and dangerous for relatively small vessels from which fishing in deeper waters was practised. Since the Neolithic, people were mainly living in permanent settlements and they also had domestic animals at their disposal. The importance of hunting decreased rapidly, but fishing remained a major activity. The availability of domestic stock and the prolonged period during which fishing could be successfully practised must have contributed significantly to food security. It is unclear if it was the increasing human population density that triggered the exploitation of the main river, or if varying intensities of the annual floods necessitated adjustments to the existing subsistence strategy in order to compensate for the fluctuating fish yields in the floodplain. Since approximately 12,000 bp a deeper down-cutting of the Nile occurred (PAULISSEN & VERMEERSCH 1987) resulting in less intense inundations.

The available faunal data from Central Sudan do not allow us to document the shift described above for the Egyptian and Nubian part of the Nile because of the lack of fauna from older sites. Early Khartoum sites such as Khartoum Hospital, Shabona and Saggai yielded remains of open water fish (VAN NEER 1989a), showing that the technology necessary for the exploitation of the main river was also present at the same time as in the Egyptian Nile.

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