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THE ROLE OF AQUATIC RESOURCES IN THE NATUFIAN CULTURE

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Abstract

The bearers of the Natufian culture in the Levant provide ample evidence for the exploitation of aquatic resources. Sites close to the Mediterranean coastal plain, as well as others in the Jordan Valley yielded both direct and indirect evidence. The direct evidence is composed of marine and freshwater fish bones that were probably consumed, as well as mollusk shells that served as ornaments. In one case it is possible that marine mollusks were also consumed, but this has not yet been confirmed. Indirect evidence is based on bone tools such as harpoons, hooks and bipoints (gorgets) apparently used as fishing gear. Additional stone artifacts may have served as net sinkers. The use of such items suggests to us that plant fibers were used for producing cordage, ropes, nets, baskets, etc. that would be necessary for the various activities involved in fishing. Fishing (and possibly shellfishing) was probably part of the strategy of a broad spectrum economy that is visible also in other faunal remains, while the large numbers of marine shell ornaments and especially the new innovation of creating shell disk beads, testifies to the importance of personal ornaments in this culture.

Key words: mollusk shells, beads, fish, broad spectrum, subsistence

INTRODUCTION

The Natufian culture (Early Natufian, 14,500–13,000 cal BP and Late to Final Natufian, 13–11,500 cal BP) originally defined by Garrod (1957) is regarded to be a major turning point in the history of the Near East societies. Studies (e.g., Bar-Yosef, 1998; Munro, 2004) exhibited that the Natufians were secondary foragers with a wide and diverse material culture that included dwelling structures, lithic industry, pounding and grinding tools, graves, art objects and ornaments, and an economy based on a wide spectrum of fauna and flora. Moreover, many of the Natufian sites are located either along the coastal plain, on the west, or along the Jordan River basin with its associated lakes in the east. These habitats are ideal for habitation and for exploitation of aquatic resources such as mollusks and fish. Surprisingly, although the Natufians broad spectrum economy has been widely discussed in the literature (e.g.,Edwards, 1989; Stiner, 2001; Munro, 2004) the role of aquatic resources has not been studied as well as other faunal resources.

While some may regard water as a barrier, others view it as a rich resource (Bird *et al.*, 2002; Erlandson, 2001) that can provide fish, shellfish, crustaceans (e.g., Jerardino and Navarro, 2002; Losey *et al.*, 2004), echinoderms (Campbell, 2008), sea mammals (e.g.,Yesner, 2004), sea turtles (Levin, 2007) and more. This wide range of aquatic resources can be easily obtained all year round, providing economic stability to hunter-gatherer populations (Bannerman and Jones, 1999; Hayden *et al.*, 1987; Nicholas, 1998; Keegan, 1986; Tveskov, 2003). Moreover, studies show that, except for deep-sea and sea-mammal fishing, there is no need to call upon increased technological efficiency to explain intensification of maritime exploitation (Bird *et al.*, 2002;

Rick and Erlandson, 2000; Yesner, 1980). Although the exact timing and intensity of coastal resource use in human prehistory is still unclear (e.g.,Rick and Erlandson, 2000; Rick *et al.*, 2001; Stewart, 1982; Van Neer *et al.*, 2005; Yesner, 1980) it is now assumed that early fishing involved a great deal of gathering, as is still practiced by some small-scale commercial fishermen in different parts of the world (Gunda, 1984; Stewart, 1982; von Brandt, 1972). Therefore, it is reasonable to assume that food of aquatic origin played a major role in the subsistence economy of Levantine prehistoric people.

Although remains of shellfish and fish were recovered in many archaeological sites, relatively little research has been done in the Mediterranean (e.g.,Stiner, 1994; Van Neer *et al.*, 2005) especially in comparison to studies performed in other regions of the world (e.g.,Bar-Yosef Mayer, 2005a). It is important then to consider why aquatic resources were used nonetheless during certain periods. Here, for the first time, we will review the evidenes of aquatic exploitation by the Natufian people of the southern Levant.

THE EVIDENCE FOR NATUFIAN EXPLOITATION OF AQUATIC ENVIRONMENTS

The discussion of aquatic resources is based on several lines of evidence. The remains of marine fauna in the sites, most notably mollusk shells and fish bones, can be considered as primary evidence, while remains of implements made of bone and stone may be considered as secondary evidence based on fishing tools. The variations in aquatic exploitation are examined here in terms of the number of identified specimens (NISP) and taxonomic richness (S species or S genera or S families; Zohar and Belmaker, 2005). When possible estimations of body size and weight will be given.

We will discuss not only what was collected from the seas, lakes and rivers, and how they were collected, but also how the mollusks and fish were used. These include both food and non-utilitarian uses, such as ornaments.

Fig. 1. A selection of gastropods and bivalves from Hayonim Cave. 1–5, *Conus* sp.; 6–9, *Nassarius gibbosulus*; 10, *Cerastoderma glaucum*; 11–15, *Columbella rustica*; 16–19, *Theodoxus* sp

Fig. 2. A group of *Antalis* shells from a single burial at Hayonim Cave

Faunal evidence

Marine and freshwater mollusks

Mollusks, especially of marine origin, are found rather consistently since the Middle Palaeolithic, with shells used as beads as early as 100,000 BP at Skhul and Qafzeh caves (Bar-Yosef Mayer *et al.*, 2009; Garrod and Bate, 1937; Vanhaeren *et al.*, 2006). Their presence increases significantly throughout the Upper Palaeolithic and Epi-Palaeolithic (Avnimelech, 1937; Reese, 1982; Bar-Yosef Mayer, 2005b). A noticeable change occurs in the Early Natufian, and is expressed in a significant increase in numbers of shells in a few key sites, namely, Hayonim Cave and terrace, el-Wad Cave and terrace and Eynan. Whereas in Upper and Epi-Palaeolithic sites the most common species include *Nassarius, Columbella, Mitrella* and other small gastropods, as well as some *Glycymeris* and *Dentalium*, and they number in the dozens, the Natufian sites mentioned contain hundreds of shells (as opposed to dozens before), with scaphopods (the class that consists of *Dentalium* and *Antalis*) being dominant (Figs. 1, 2; Bar-Yosef Mayer, 2008). Their abundance in graves, and especially their adorning both crania and post-crania is noteworthy (McCown and Keith, 1939; Belfer-Cohen, 1988; Belfer-Cohen, 1995; Valla *et al.*, 2007). Smaller sites especially in the Negev and Jordan valley (e.g.,Salibiya I, Crabtree *et al.*, 1991; Saflulim in the Negev highlands, Goring-Morris *et al.*, 1999; Beidha in Jordan, Reese, 1989) usually had moderate numbers of shells. Table 1 presents Natufian shell finds of selected assemblages in the Levant.

The long distance trade or exchange of shells is expressed in species that are found a long distance from their origin. This is the case of *Euplica turturina* from the Red Sea discovered as far as Salibiya I (Crabtree *et al.*, 1991), or *Theodoxus jordani*, a small freshwater gastropods form the Jordan river basin, discovered in the Negev highlands.

Table 1

Mollusk shells at selected Natufian sites

	Early Natufian					Late Natufian									
Species / site	Eynan	Hay-onim Ter-race C+D	Hay-onim Cave	El Wad Cave B	Sali-biya I	Rake-fet Cave	Saf-lulim	El Wad Ter-race 1	El Wad Ter-race	Gilgal II	Hat-oula	Hay-onim Ter-race B	Bei-dha	Jay-roud sites	Abu Hur-eyra
Patella				x					23						
Osilinus				x					2						
Theodoxus	102		x	x	3				2			3		2	13
Cerithium		4							2						
Cypraea	1	1		x									1	1	
Muricidae				x					1	1	1				
Pisania									1						
Columbella		99	x	x	2			15	13			13	1	6	
Mitrella		38													
Nassarius		7		x	42	1	16	2	6	12	7			9	87
Conus	1	10	x	x				2	4		3				
other gastropods	3	2	x		2		2						6	1	
Arca noae				x							1				
Glycymeris		1		x					13	1	6				
Pinna				x											
Ostrea				x											
Unio															1
Acanthocardia		6	x												
Cerastoderma		5	x	x		1			13		4			1	
Donax				x					3					1	
other bivalves		1	x								1		1		
Scaphopods (dentalium, antalis)	227	603	4000+	x	173	36	152	70		19	28	27	64	22	9
TOTAL	334	777	4000<	un-known	222	38	170	89	83	33	51	43	73	43	110
Reference	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O

References: A – Mienis 1987; B – Reese 1982 Paleorient; C – Kurzawska *et al.* in preparation; D – Garrod & Bate 1937; E – Crabtree *et al.* 1991; F – Nadel et al. in press; G – Goring-Morris et al. 1999; H – Valla *et al.* 1986; I – Weinstein Evron *et al.* 2007; J – Bar-Yosef Mayer in press; K – Bar-Yosef 1994; L – Reese 1982; M – Reese 1989; N –Marechal 1991; O –Marechal 1991

Dentalium shells in large quantities were recognized as hallmarks of the Natufian culture by Garrod (1957). Those were collected mostly from the Mediterranean but also from the Red Sea and from fossil exposures (e.g.,Avnimelech, 1937; Bar-Yosef *et al.*, 1974). One such exposure was recently noticed in the Hatay region in southeastern Turkey (Stiner and Kuhn, 2003). Most exposures containing *Dentalium* in the Levant are from Upper Cretaceous or Pliocene levels, where the shells are either too mineralized or too fragmentary to serve as beads (Moshkovitz, 1968; Kurzawska *et al.*, 2009; Zeev Levy, Israel Geological Survey, personal communication).

There are clear differences in the use of *Dentalium* between Early and Late Natufian: In the Early Natufian *Dentalium* shells are long, approximately 8–25 mm long, and present in burials as well as occupation levels (e.g.,el-Wad Cave, Hayonim Cave B, lower levels of Eynan), whereas in the Late and Final Natufian levels they are absent in burials and become shorter. This was observed especially in sites such as Eynan, Hilazon Tachtit Cave and el-Wad Terrace. In some cases such as the Final Natufian of Eynan most shells are as short as 1–3 mm.

Natufian assemblages exhibit modest numbers of *Nassarius* and *Columbella*, *Glycymeris* and *Cerastoderma*, as well as various other gastropods and bivalves (e.g.,muricids, cones, *Theodoxus*, *Unio*, *Mactra*, *Cypraea* etc.) as is true for earlier Epi-Palaeolithic assemblages (Valla *et al.*, 2004, 2007).

One innovation that comes towards the end of the Natufian is the production of an artifact, a bead, in which the original shape of the shell from which it is made cannot always be recognized. This was first observed in the Final Natufian at Eynan, hence shell is now used as "raw material". At Eynan there were a few disc beads[1] made of both mother of pearl (of an unidentifiable shell, but it is probably the local freshwater *Unio* sp.), and of *Cerastoderma glaucum* from the Mediterranean (Valla *et al.*, 2004, 2007).

Of special interest are the assemblages of el Wad Cave and el Wad Terrace in Mt. Carmel, since those are the Natufian sites closest to the Mediterranean known today.

Shells were discovered in el-Wad Cave in Garrod's excavations in the 1930's, and were published only as a list of species (Garrod and Bate, 1937: 224). The list includes 8 different species of landsnails, one species of freshwater snail, and sixteen different species of marine shells, exhibiting species richness larger than in any other Natufian site. Recent excavations of el-Wad Terrace revealed a similar species composition to that of the cave. However, the most intriguing of the species present there is *Patella*, also discovered both in the cave and terrace. While most marine shell species, and especially the small gastropods and scaphopods served as personal ornaments, the *Patella* is an edible species and may have been collected as food, unlike most other mollusks.

Another edible mollusk, *Unio*, a freshwater bivalve was present in large numbers at Eynan, which is likely to suggest that it served as food, and that the shells were then also used for making disk beads (Mienis, 2004). It is worth noting that another mollusk, *Levantina spiriplana caesareana*, a landsnail, was brought to the site especially to be consumed (Valla *et al.*, 2007: 315–319).

Fish remains

A comprehensive overview of fish exploitation during the Natufian is based on bibliograpical data complemented by unpublished information from sites that we are currently studying. In Table 2 we present summary of fish remains recovered in seven Natufian sites. For each site the number of fish bones, the taxonomic identification to family and species level, species richness (S), habitat exploited and possible fishing tools are indicated. The amount of bones is usually low since most of the remains were not sorted nor studied yet and in many cases are based on personal observations of one of us (I.Z.). As a result the possibilities of interpretations are limited and biased toward larger samples, as will be observed in species richness and estimated body sizes. Despite the biases mentioned above we have attempted to examine variations in habitat exploited (freshwater vs. Mediterranean fish), in species richness (number of species; Table 2) and the relative abundance of high ranked fish compared to low ranked prey (Butler, 2000, 2001; Stiner, 2001), to examine changes in fish exploitation pattern and fishing techniques. For comparison we added data from an early Epipaleolithic site (Ohalo-II) and from some Pre Pottery Neolithic sites (Hatoula and Atlit-Yam).

Clear evidence for fishing activity and intensive fish exploitation is observed at the site of Ohalo-II, dated to 23,000 BP (Nadel, 1995; Zohar, 2002, 2003; Van Neer *et al.*, 2005). The inhabitants of Ohalo-II were engaged in freshwater fishing activity along the paleo shore of Lake Kinneret (Sea of Galilee) and the Jordan River. The major fish taxa exploited were Tilapinii (St. Peter fish) and carps such as *Barbus* and *Capoeta* (See Table 2). Despite the low diversity in families exploited (S=2) seven different fish taxa were captured with body size ranging between 14 to 50 cm in standard length for the cyprinids.

Early Natufian sites that contain fish remains are Hayonim Cave and Kebara Cave. At Hayonim Cave B several hundreds of fish remains were recovered but not yet studied. A sample of 118 fish bones included two families of freshwater fish:

Table 2

Summary of fish remains recovered from selected archaeological sites dated from 23,000 BP to 8,000 BP

Period	Site	Location	Number of Fish remains (NISP)	Families identified	Species identified	Species richness (S)	Habitat exploited	Possible fishing methods	Reference
Early Epipa-leolithic	Ohalo-II	Lake Kinneret	>20,000	Cichlidae Cyprinidae	*Tilapia aurea* *T. zillii* *Tristamella* sp. *S. galilaeus* *Carasobarbus canis* *Barbus longiceps* *Capoeta damascina*	S=7	Freshwater	weights, rope, weirs trap smicrolithic, arrowheads Poison	
Early Natufian	Hayo nim Cave B	Western Galilee	Ca. 118	Sparidae Cyprinidae Clariidae	*Sparus* sp. Unidentified marine species Unidentified carps *Clarias gariepinus*	S>3	Mediterra-nean Freshwater	Stone or bone points and hooks, harpoons & spears	(Stiner & Munro, 2002), pers. obs.
	Kebara Cave B	Mt. Carmel	3	Sparidae	*Chrysophrys auratus*	S=1	Mediterra-nean		Saxon 1974
Late Natufian	Hilazon Tachtit Cave	Western Galilee	>67	CyprinidaeMugilidae		S>2	Fresh-water Fres-hwater	-	pers. obs.
	El-Wad Terrace	Eastern Mediterra-nean	62	Sparidae SerranidaeMullidae Muglidae	*Sparus aurata* *Epinephalus* sp. *Upeneus* sp. *Liza* sp.	S>4	Mediterra-nean	Stone or bone points and hooks, harpoons & spears	(Valla *et al.*, 1986), pers. obs.
	Raqefet Cave	Mt. Carmel	2	Unidentified					Nadel *et al.*, in press
	Hatoula	Judean Hills	26	Serranidae Sparidae Sciaenidae Muglidae	*Epinephalus* sp *Sparus aurata* *Argyrosomus regius* *Mugil cephalus* *Mugil* sp.	S>4	Mediterra-nean	Imported ma-rine fish	(Davis, 1985; Lernau & Lernau, 1994; Van-Neer *et al.*, 2005)
Final Natufian	Mallaha (Eynan)	Jordan Valley	>5,000	Ciclidae Cyprinidae	*Oreochromis aureus* *Tristramella simonis* *Mirogrex hulensis* *Acanthobrama lissneri* *Carasobarbus canis* *Barbus longiceps* *Capoeta damascina* *Clarias gariepinis*	S=8	Fresh-water	weights, microlithics, weirs, traps, baskets, poisons, harpoons & spears	(Desse, 1987; Valla *et al.*, 2007)
PPNA Khiamian	Hatoula	Judean Hills	132	Serranidae Percichthyidae Sparidae Sciaenidae Muglidae Scombridae	*Epinephalus aeneus* *E. guaza* *E. alexandrinus* *Dicentrachus labrax* *Sparus aurata* *Diplodus sargus?* *Argyrosomus regius* *Mugil cephalus* *Euthynnus aleteratus*	S=9	Mediterra-nean	Imported ma-rine fish	(Davis, 1985; Lernau & Lernau, 1994; Van-Neer *et al.*, 2005)

Table 2 continued

Period	Site	Location	Number of Fish remains (NISP)	Families identified	Species identified	Species richness (S)	Habitat exploited	Possible Fishing methods	Reference
PPNA Khiamian	Hatoula	Judean Hills	664	Serranidae Percichthyidae Carangidae Sparidae Sciaenidae Muglidae Elasmobranchii Cyprinidae Cichlidae	*Epinephalus aeneus* *E. guaza* *E. alexandrinus* *Dicentrachus labrax* *Seriola dumerili* *Sparus aurata* *Dentex dentex?* *Lithognathus mormyrus* *Pagellus erythrinus?* *Argyrosomus regius* *Sciaena umbra* *Mugil cephalus* *Liza ramada* *Rajja* sp. *Capoeta damascinal* *Barbus* sp. *Tilapia zillii*	S=9	Mediterra-nean Freshwater	Imported ma-rine fish	(Davis, 1985; Lernau & Lernau, 1994; Van-Neer *et al.*, 2005)
PPNC	Atlit-Yam	Eastern Mediterra-nean	>6000	Balistidae Serranidae Carangidae Mugilidae Sparidae Sciaenidae Elasmobranchii	*B. carolinenesis* *Epinephalus marginatus* *E. aeneus* *Seriola dumerili?* *Mugil cephalus* *Sparus aurta* *Dentex* sp. *Pargus* sp. *Lithognathus mormyrus* *Arygrosomus regius* *Raja* sp.	S>11	Mediterra-nean	weights, spears, arrowheads, harpoons, microlithics, weirs traps poison	(Galili *et al.*, 1993; Zohar *et al.*, 1994; Galili *et al.*, 2004)

Cyprinidae and Clariidae and a single family of marine and estuarine fish: Sparidae (Stiner and Munro, 2002, and personal observation). Sparidae was also identified from Layer B of Kebara Cave (Saxon, 1974), represented by a single maxilla bone of *Chrysophrys auratus*; (Gilthead fish).

Fish remains are more abundant from Late Natufian sites such as Raqefet Cave, Hilazon Tachtit cave, el-Wad Terrace, and Hatoula. At Raqefet cave two unidentified fish bones were recovered (Nadel *et al.*, 2008). At Hilazon Tachtit cave (Grosman, 2003) 67 fish remains were sampled and included two families: Cyprinidae and Mugilidae. While Cyprinidae are primary freshwater fish that cannot tolerate changes in salinity level, the Mugilidae tolerate high salinity levels and can be captured in freshwater, estuarine and marine habitats.

Exploitation of the Mediterranean coast is observed from the fish remains recovered at El-Wad terrace. Despite the low number of fish remains studied so far (NISP=62) four species, each from a different family were identified (Valla *et al.*, 1986; Van-Neer *et al.*, 2005; Weinstein-Evron *et al.*, 2007). The presence of these species indicates that the Natufian inhabitants of El-Wad were engaged in exploitation of the Mediterranean littoral and estuarine zones.

The site that best exhibits the importance of Mediterranean fish to the Natufian population is Hatoula located ca. 25 km east of the current Mediterranean coast. Despite the distance between the coast and the site, and despite the low number of fish remains (NISP=26) five species from four families of Mediterranean fish were identified (Table 2; Lernau and Lernau, 1994). These included fishes from the families Serranidae, Sparidae, Sciaenidae and Mugilidae suggesting that fish were preserved and later transferred either by the inhabitants or obtained by exchange with Natufians that transferred goods between coastal and inland sites. The relative increase in fish remains, NISP and richness (S=17) at the Pre Pottery Neolithic A of Hatoula (Table 2) suggests that the inhabitants were engaged in seasonal marine exploitation and long-term fish preservation.

As much as the inhabitants of Hatoula preferred to consume marine fish, the inhabitants of the Final Natufian site of Eynan (Mallaha) were heavily engaged in exploitation of the freshwater habitat in their vicinity. Eight species from three families (Cyprinidae, Cichlidae, Clariidae; Table 2) were identified at Eynan (Valla *et al.*, 2004: 143; Valla *et al.*, 2007), representing fish with body sizes from 15 cm in length. Some of the identified species such as *Tristramella simonis* and *Mirogrex hulensis* are endemic and characteristic of this habitat.

In all, despite the low number of fish remains identified and studied from Natufian sites a relatively high species richness is observed. The fish remains recovered at the seven Natufain sites (Table 2) clearly demonstrate that freshwater habitats were fully exploited, and included low ranked fish such as *M. hulensis* and high ranked fish such as medium to large sized tilapinii and carps. However, when marine habitats are close then there is a clear preference toward exploitation of marine fish. The relatively wide range of fish body sizes observed and the presence of littoral and estuarine fish may indicate the use of a variety of low cost fishing techniques such as weirs, baskets, traps, nets and poison.

Other aquatic faunal remains

We have very little evidence for aquatic fauna other than mollusks and fish, due to their scarcity at the sites. Aquatic invertebrates, especially arthropods (such as crabs) remains were reported from several shell middens (de France, 1989; Losey *et al.*, 2004) in different regions, however, in the Levant they are mostly rare[2]. A few pincers of crab identified as *Potamon* sp. (the freshwater crab) were reported from the Natufian level of Hatoula (Davis *et al.*, 1994), Eynan (Valla *et al.*, 2004: 143) and Wadi Hammeh 27 (Edwards, 1991: 146). However, we cannot ascertain whether the crabs remains represent food or natural deposition.

Additional evidence for marine activities

Marine activities or exploitation of marine resources are encountered in lithic and bone tools that served especially for fishing. Fishing methods are too numerous to be detailed here (e.g.,see Stewart, 1982; von Brandt, 1972), but those determine the fishing gear that we should expect to find. Some of the methods will leave material remains, while others (catching by hand) will not bear physical evidence. Rarely botanical remains can be related with fish poisoning (i.e. Galili *et al.*, 2004; Neuwinger, 2004). Harpoons of various types, fish hooks, and fish gorgets are among bone tools encountered in the Natufian archaeological record (Fig. 3). If any were made of wood they decayed and were not found. Several examples in the archaeological record include barbed points, usually referred to as harpoons, and are known from Kebara Cave (Turville-Petre, 1932), el-Wad Cave (Garrod and Bate, 1937: 37), Raqefet Cave (Nadel *et al.*, 2008), Eynan (Valla *et al.*, 2004, 2007) and Antelias Cave in Lebanon (Copeland, 1991: 34, Fig. 2: 17, 22). Fish hooks were discovered at Kebara Cave and at Eynan (Turville-Petre, 1932; Valla *et al.*, 2004, 2007), and in at least one case were made of tusk (Campana, 1989: 41). Gorgets are thin double-pointed bone implements. Apparently a rope would be tied in the center, and possibly a piece of bait at the end, so that essentially it catches the fish in a similar way to that of a hook. Those were found at Hayonim cave, el-Wad cave (Garrod and Bate, 1937: 37, pl. XII), at Kebara Cave (Turville-Petre, 1932), Hilazon Tachtit (Grosman, 2003: fig. 5: 2) and at Eynan. Campana (1989: 89) suggests that while some of these implements may have been used in fishing, this is not necessarily always the case. Two long fish spines recovered at Kebara cave may either represent consumed fish or secondary use of the fish's natural anatomy as gorgets.

It is worth noting that bone tools, mainly points, that are very common in Natufian sites (Campana, 1989) were also discovered at Ohalo II, an early Epi-Palaeolithic site, where they are assumed to have been used in the production of fishing nets. Thus those are indirectly related to fishing (Nadel *et al.*, 1994; Rabinovich and Nadel, 1994-5: 32–63).

Fig. 3. Bone implements for fishing from el-Wad and Kebara caves. 1, 2 – fish spines; 3, 4 – bone gorgets; 5–11 – harpoons; 12, 13 – hooks

Another interesting bone artifact that may be relevant, is a "toothed object" from Kebara Cave (Campana, 1989: 106) that could have served as a fish scaler, based on the wear observed by Campana. Similar artifacts made of shell and assumed to have served as fish scalers were discovered in Early Bronze Age I sites in Israel (MacDonald, 1932; Horwitz *et al.*, 2002).

In addition to bone points, stone implements also played a role in fishing. Fishing nets would have been tied to net sinkers at the bottom and floaters on top. The identification of such artifacts is rather enigmatic because they are not formal tools. However, notched stones that could have served as net sinkers were recognized in several sites, mostly of earlier Epi-Palaeolithic age (Perrot, 1966: 481, fig. 20; Nadel and Zaidner, 2002). Complementing them are net floaters that would have been tied to the top part of the nets. Some light artifacts (probably made of wood, but the material of which they are made is under investigation) with an incision along their perimeter were discovered at Eynan and may have served this purpose. Perrot (1966: 473, fig. 21) identified them as beads, while Belfer-Cohen (in Valla *et al.*, 2004: 219, fig. 73: 4) claimed they are weight stones. Because of their light weight we suggest they were in fact the floaters tied to the top part of a net. A similar artifact was noted at Wadi Hammeh 27 (Edwards, 1991: Fig. 8, no. 4).

Since in some parts of the world double pointed stone artifacts are also used in fishing in the same manner as bone gorgets, we suggest that any small double pointed tool may serve in this capacity. The most obvious candidates are microliths such as trapezes and lunates, as well as fish spines to which a rope is tied and bait is placed on the pointed ends (Allen, 1996). This suggestion requires further investigation, especially in light of recent experimental studies on microliths (Yaroshevich *et al.*, 2010).

The evidence we do not have, or: other potential resources

Aquatic sources consist not only of aquatic fauna, but also of aquatic flora. Various seaweeds were (and are) used by humans in different parts of the world both as a food source, a medicinal source, and as raw material (McHugh, 2003). In the Mediterranean, *Ulva lactuca*, the sea lettuce, is an edible species, but many other species exist as well. Historic resources mention use of seaweeds as medicinal remedies (Khalilieh and Boulos, 2006). Seaweed can also be used to make cordage, ropes and baskets for uses related to fishing (Vellanoweth *et al.*, 2003). In the Levant, to date, there is no evidence for such use of marine flora. Nor is there direct evidence for traps and nets made of wood, stems, bark, rattan, rope, and so on, made of terrestrial plants. Basketry would have also been important equipment for the collection and transportation of fish as well as shells collected on the beach.

In many societies the flesh of mollusks serves as bait for fishing. Most mollusk shells in Natufian, as well as in most sites in the Levant, were collected as empty dead shells, so we assume, that if mollusks served as bait, their shells would have been discarded and not used as ornaments.

DISCUSSION AND CONCLUSIONS

The Natufian culture dominates the end of the Epi-Palaeolithic and is considered to be the precursor to the "Neolithic Revolution" (e.g.,Bar-Yosef, 1998). One of the characteristics of this transition is expressed by increased sedentism. This sedentism, however, is accompanied by increased long distance exchange actions, that could also be viewed as higher mobility. The exchange activity is manifested by the occurrence of artifacts made of obsidian originating in Anatolia, and basalt originating from the Golan Heights (Weinstein-Evron *et al.*, 1999). This dynamic system of goods trade and exchange is part of an increasing complexity of economic resources, and within it, the aquatic resources seem to have played an important role. Both shell and fish were transferred over long distances from their original habitat. For example, shells from the Red Sea and the Nile River (*Chambardia rubens*, previously called *Aspatharia rubens*; Mienis, 1987) were recovered in the Upper Jordan Valley, at Eynan. Mollusk shells were used and highly valuable primarily as ornaments, and as such were traded between the coastal and inland populations (Bar-Yosef, 1991; Bar-Yosef Mayer, 2005b, 2008). Mediterranean fish were transferred from the coast inland, as observed in the remains recovered at the site of Hatoula in the Judean hills.

To date there is no firm evidence for systematic exploitation of shellfish in the Natufian, and the collection of shellfish is regarded as a slow process that takes up much time and does not yield very large amounts of flesh (Claassen, 1998). If Natufian shell middens existed along the Mediterranean, those could be discovered only as submerged sites (see Bailey *et al.*, 2007). Furthermore, the ocean has other food types to offer, including seaweed, various echinoderms (especially sea urchins), and probably less popular are sea worms known to be consumed in a few geographic areas (Mondragón, 2004). Crustaceans, and cephalopods (squid, octopus, etc.) may have been consumed without leaving material remains. Fish, on the other hand, are much more profitable when compared to mollusks, and can be obtained relatively easily with no need to call upon sophisticated gathering methods. Unlike all other aquatic food sources, fish are present in Natufian sites, probably in larger quantities than previously realized.

Despite the limited information available from fish bones in the Natufian archaeozoological record, the data used in this paper points towards freshwater fish having been exploited only when the sites were located in the vicinity of a freshwater habitat. However, when marine habitats were in the range of ca. 10–20 km from the site, there is a clear preference of littoral and estuarine fish. The species identified demonstrate that fish exploitation was not targeted toward a particular species or body size but rather toward the littoral and estuarine zones. This exploitation trend continues in later periods (Van Neer *et al.*, 2005). The collection of large numbers of beach worn shells, as well as a few *Patella* shells recovered that may have been food debris is further testimony for exploitation of the littoral zone.

The Natufians, being highly skilled technologically, likely produced ropes, nets, weirs, baskets, bone harpoons and spears as well as all other fishing implements mentioned above (e.g., Glassow and Wilcoxon, 1988). The fish recovered at Hatoula testify that fish were preserved for later consumption and traded with inland populations.

The reliance on aquatic resources that served as food, and in particular marine resources, is likely to reflect a relationship of cost vs. benefit, otherwise known as the "schlepp-effect" (Perkins and Daly, 1968). As mentioned above, populations that include aquatic resources in their subsistence economy exploited a wider range of supplies that can be easily obtained all year round, with no need of special technological skills or tools (Bannerman and Jones, 1999; Hayden *et al.*, 1987; Nicholas, 1998; Keegan, 1986; Tveskov, 2003).

When considering the overall evidence for diet among Natufians, mammals hunting is regarded to be highly cost effective, as a major supply of meat, yielding energy and proteins, as well as bi-products (hide, bone, etc.; Munro, 2004 and references therein), while the aquatic fauna is regarded as "low rank". Yet the addition of "low ranked" and diverse aquatic fauna contributes to a "broad spectrum" of resources (e.g.,Stiner and Munro, 2002), and it is in this context that aquatic consumption should be viewed.

We thus identify an aquatic adaptation that is based both on freshwater and coastal regions which provide a wider economic stability. The aquatic remains recovered in the Epi-paleolithic site of Ohalo-II and those from Natufian sites such as El-Wad, Hatoula and Eynan exhibits the impact of aquatic resources in determining the group structure and the density of occupation. In other words, aquatic exploitation is a major component in determining the nature of the population distribution across the landscape (Whitlam, 1983) and in seasonal and cyclical occupation of the sites.

The broad spectrum that was at the core of the Natufian economy would have led to sedentism and the "agricultural revolution" that followed (Bar-Yosef, 1998), which is manifested in intensification and domestication that are linked to the need for predictable day-to-day access and scheduled consumption (Marshall and Hildebrand, 2002: 104). The topic of marine resource exploitation at the end of the Epi-Palaeolithic period has never before been addressed in depth, although the little evidence presented here testifies to considerable activity. This issue certainly deserves further investigation. A rigorous study of Natufian fish remains will allow us to better assess the role of aquatic resources in this culture's economy.

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Notes

1. A disc bead according to Beck, 1928, is one in which the length is less than a third of the diameter
2. An exceptional large number of freshwater crab remains (>5,000) were reported from the Middle Pleistocene Acheulian site of Gesher Benot Ya'aqov (Ashkenazi *et al.*, 2005).