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Length-weigth relationships for syngnathid fishes of the Aegean Sea, Turkey

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ABSTRACT. In this paper we present length–weight relationships of three pipefishes, *Syngnathus acus*, *Syngnathus typhle Nerophis ophidion,* and two seahorse species, *Hippocampus hippocampus, Hippocampus guttulatus* from İzmir Bay, on the Turkish coasts of the Aegean Sea. Overall, 1010 specimens of five different species of Syngnathidae were weighed and measured. The sample size ranged from 29 for *H. hippocampus* to 570 for *S. acus*. The values of the exponent *b* in the length–weight regressions ($W=aL^b$) varied between 2.42 (*N. ophidion*) and 3.54 (*S. acus*). Linear regressions of length–weight relationships were significant for all species. Positive allometry in weight vs. length for *S. acus*, isometry in *S. typhle* and *H. hippocampus* and negative allometry for *H. guttulatus* and *N. ophidion* were observed.

KEY WORDS : Length–Weight Relationship, Pipefish, Seahorse, Aegean Sea, Turkey

INTRODUCTION

Estuaries are nursery and over-wintering areas for many marine fish species (Beyst et al., 1999). Fishes of the Sygnathidae are typically small and cryptic and are associated with vegetated and epibentic habitats (Pollard, 1984; Kuiter, 2000). Syngnathids are among the most abundant groups in seagrass-associated fish communities of the benthic habitats (Pollard, 1984). In terms of a community dominance index, syngnathids were the highest ranked family for both the Atlantic-Mediterranean and Indo-Pacific region in benthic habitats (Howard & Koehn, 1985; Vitturi et al., 1998). The Mediterranean and Western Atlantic species migrate seasonally, moving into shallow, vegetated areas during spring and remaining there until the late fall when migration back to the deeper channel areas occurs (Mercer, 1973; Dawson, 1982). However, a small numbers of individuals may overwinter in seagrass beds (Dawson, 1982). The genus *Syngnathus* is represented by nine species in the Mediterranean (Dawson, 1982; Bilecenoglu et al., 2002) and six species in the Aegean Sea (Bilecenoglu et al., 2002). The genus *Hippocampus* is represented by two species in Aegean Sea (Whitehead et al., 1986; Bilecenoglu et al., 2002). A review of the current literature indicates that little is known about biology and growth rate of pipefish and seahorses in the Mediterranean basin.

Length-weight relationships of fish, in general, are important because they: (a) allow an estimate of the condition of fish; (b) allow the estimation of biomass from length observations; (c) allow the conversion of growth-in-length equations to growth-in-weight; and (d) are useful for between-region comparisons of life histories of species (Pauly, 1993; Gonçalves et al., 1996; Binohlan & Pauly, 1998). Length-weight relationships are also originally used to provide information on the condition of fish and may help determine whether somatic growth is isometric or allometric (Ricker, 1975).

Information about length-weight relationships for the pipefish and seahorse species from Aegean sea is scarce and incomplete (Koutrakis & Tsikliras, 2003; Valle et al., 2003; Lamprakis et al., 2003; Verdiell-Cubedo et al., 2006). Regarding Turkish seas, only two studies focus on syngnathid fishes, dealing with aspects of diversity and abundance of the family Syngnathidae from Erdek Bay, the Sea of Marmara (Keskin et al., 2002) and the ecomorphology of the pipefish (Familia: Syngnathidae) distributed in the Camalti Lagoon, İzmir Bay (Gurkan, 2004). Studies on length-weight relationships for the Turkish seas are mainly related to fish having an economic importance. A single document by Ozaydin & Taşkavak (2006), who studied length-weight relationships for 47 fish species from İzmir Bay, gives any information on length-weight relationships for three species of pipefish, *Syngnathus acus, S. typhle* and *Nerophis ophidion*.

We, here, report length–weight relationships for three pipefish and two seahorse species from İzmir Bay in the eastern Aegean Sea.

MATERIALS AND METHODS

Between 2000 and 2002, the pipefish species, *Syngnathus acus*, *Syngnathus typhle* and *Nerophis ophidion,* were obtained monthly with trammel nets (mesh sizes-bar lengths: 22, 24, 26 and 28mm) in the Camalti Lagoon, İzmir Bay (Aegean Sea) (Fig. 1). Specimens of two seahorse species, *Hippocampus hippocampus* and *Hippocampus guttulatus* were obtained from commercial fishermen on February 2000. *H. hippocampus* and *H. guttulatus* specimens were based on a single sampling since this type of fishing (beach seine) was prohibited along the Turkish coasts thereafter. Lengths (TL – total length – for pipefish and SL – standard length – for seahorse) were measured to the nearest mm and animals were weighed (W) to the nearest g. Standard length of seahorse is expressed as sum of head length, trunk length and tail length, using a curved measurement of trunk length from the midcleithral ring to the last trunk ring (Lourie et al., 1999).

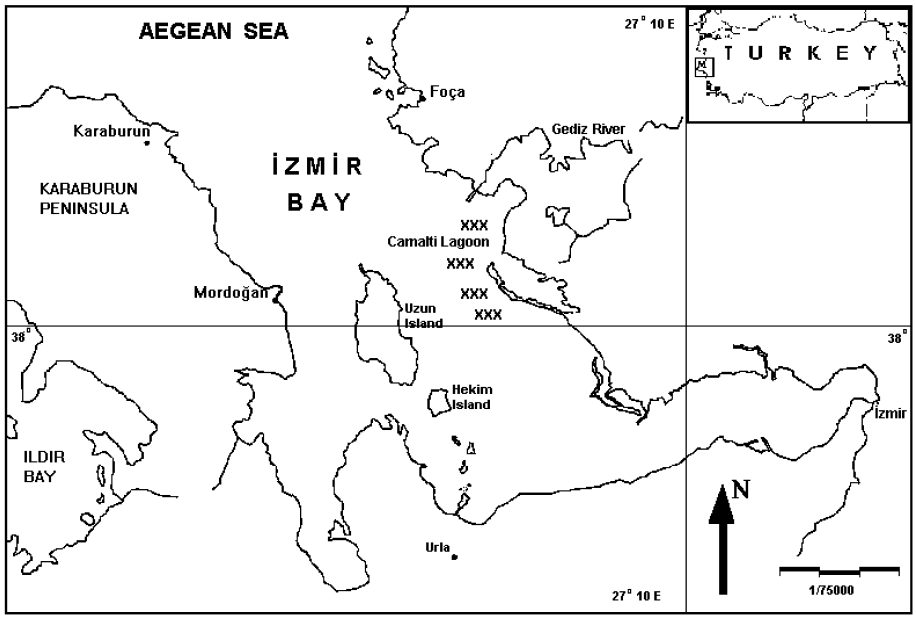

Fig. 1. – Map showing the location where sampling was carried out.

Length to weight relationship for total body weight was calculated using the equation $W=aL^b$, where W is weight (expressed in grams), L is length (TL and SL, expressed in mm), a is the intercept, and b is the slope. The degree of association between the variables was computed by the determination coefficient, r^2. The parameters a and b were estimated by linear regression on the Log-transformed (Log_{10}) equation $log(W)=log\ (a)+\ b\ log\ (L)$. The significance of the regression was assessed by ANOVA, and the b-value for each species was tested by t-test to verify that it was significantly different from the predictions for isometric growth (b=3).

RESULTS AND DISCUSSIONS

Members of the Family Syngnathidae consistently form an important component of the ichthyofauna of vegetated estuarine habitats and are among the most abundant groups in this type of habitat (POLLARD, 1984). Although the fishes of the family Syngnathidae are not economically important, they are significant from the aspect of ichthyofauna conservation and overall fish diversity (CAKIĆ et al., 2002).

Overall, 1010 specimens of five different species of Syngnathidae were weighed and measured to estimate length-weight relationships. The sample size ranged from 29 for *Hippocampus hippocampus* to 570 for *Syngnathus acus*. During the course of the study, *S. acus* was the most abundant one. Length-weight relationships of three pipefish and two seahorse species examined for the İzmir Bay (Aegean Sea) are given in Table 1. Relationships (linear regressions) were significant for all species (P<0.001), with r^2 values being greater than 0.95 for *S. acus* and *S. typhle*; and about 0.75 for *Nerophis ophidion* and *H. hippocampus*; the single exception was *H. guttulatus* (r^2=0.64 and P<0.05).

Values of b equal to 3 indicate that the fish grows isometrically; values different from 3 indicate allometric growth. The exponent b varied between 2.42 for *N. ophidion* and 3.54 for *S. acus* (Table 1). An over-proportional increase in length relative to growth in weight is reflected in an exponent of b<2.5 or to the contrary, an exponent of b>3.5 indicates an over-proportional increase in weight relative to growth in length (FROESE, 2006).

TABLE 1

Descriptive statistics and estimated parameters of the length–weight relationship for five species collected from the bay of İzmir, Aegean coast of Turkey (N: sample size, S.E.: standard error, Range: minimum and maximum, a and b: parameters of the length–weight relationship, r^2: coefficient of determination, Mean L: Mean Length in mm, Mean W: Mean Weight in g., and TL: Total length in mm.

Species	N	Length Characteristics		Weight Characteristics		$W=aL^b$		
		Mean L±SE	Range	Mean W±SE	Range	a	b±95%C.I	r^2
S. acus	570	100.98±1.09	33-256	0.60±0.04	0.01-12.29	6E-08	3.54±0.03	0.95
S. typhle	125	155.37±3.74	40-258	1.49±0.12	0.01-8.2	3E-07	3.00±0.06	0.96
N. ophidion	86	145.78±3.04	78-214	0.35±0.02	0.06-0.83	3E-06	2.42±0.16	0.74
H. hippocampus	29	113.21±0.09	80-140	3.94±0.01	0.95-6.55	0.001	3.14±0.34	0.76
H. guttulatus	200	133.33±0.09	100-165	6.54±0.01	2.54-111.88	0.010	2.47±0.13	0.64

Concerning growth types, the length-weight relationships revealed that weight increases isometrically with length for *S. typhle* (t_{cal}=0.01<$t_{0.05(124)}$=1.98) and *H. hippocampus* (t_{cal}=0.41<$t_{0.05(28)}$=2.05). Positive allometry in *S. acus* (t_{cal}=18.00>$t_{0.05(569)}$=1.96) and negative allometry in *N. ophidion* (t_{cal}=2.80>$t_{0.05(85)}$=1.99) and *H. guttulatus* (t_{cal}=4.05>$t_{0.05(199)}$=1.98) were observed. CARLANDER (1977) demonstrated that values of b<2.5 or >3.5 are often the consequence of small sample sizes. Given the sample sizes in our study this is unlikely to be the case. However, these variations from isometry may be due to the very small specimens included in the regression that had not yet reached adult body size.

Other studies conducted in Turkish waters (GURKAN, 2004; OZAYDIN & TAŞKAVAK, 2006) reported values of the scaling exponent ranging from 2.36 to 3.43 and from 2.13 to 3.63 for three pipefish species (*Syngnathus acus, S. typhle* and *Nerophis ophidion*). Our results are quite similar to those reported by GURKAN (2004) and OZAYDIN & TAŞKAVAK (2006), i.e., positive allometry in *S. acus* and negative allometry in *N. ophidion*, in spite of limited sample sizes in previous studies.

The values of the scaling exponent b for three pipefishes (Table 2) ranged from 2.13 (*N. ophidion*) to 3.73 (*S. acus*) and our results remained within the ranges given. Our results mostly agreed with the pipefish studies given in Table 2. Mean condition of specimens as well as the difference in condition between small and large specimens vary between seasons, localities and years, resulting in different length-weight relationships (FROESE, 2006). Except for data reported by VALLE et al. (2003), who measured the standard length, most of these results in Table 2 revealed that weight increases isometrically with length for *S. typhle* but allometrically for *S. acus* and *N. ophidion*, as was observed in this study.

TABLE 2

Summary of the available studies on length–weight relationship for *Syngnathus acus*, *Syngnathus typhle* and *Nerophis ophidion* in various seas (N: sample size, a and b: parameters of the length–weight relationship, r^2: coefficient of determination).

Study	Locality	N	a	b	r^2
		Syngnathus acus			
COULL et al. (1989)	Moray firth	4	0.0006	3.53	–
KOUTRAKIS & TSIKLIRAS (2003)	Greece	5	0.0001	3.73	0.96
VALLE et al. (2003)	Spain	225	0.0007	2.88	0.96
GURKAN (2004)	İzmir Bay	310	0.0001	3.43	0.89
OZAYDIN & TAŞKAVAK (2006)	İzmir Bay	202	0.0001	3.63	0.97
This Study	İzmir Bay	570	0.0001	3.43	0.91
MEAN			**0.0003**	**3.44**	
		Syngnathus typhle			
WORTHMANN (1975)	Kiel Bigth	2	0.0003	2.94	–
VALLE et al. (2003)	Spain	167	0.0002	3.17	0.96
GURKAN (2004)	İzmir Bay	93	0.0001	3.05	0.91
OZAYDIN & TAŞKAVAK (2006)	İzmir Bay	14	0.0002	3.22	0.94
This Study	İzmir Bay	125	0.0001	3.00	0.96
MEAN			**0.0002**	**3.08**	
		Nerophis ophidion			
WORTHMANN (1975)	Kiel Bigth	1	0.0002	2.72	–
GURKAN (2004)	İzmir Bay	68	0.0001	2.36	0.74
OZAYDIN & TAŞKAVAK (2006)	İzmir Bay	11	0.0009	2.13	0.82
This Study	İzmir Bay	86	0.0001	2.42	0.74
MEAN			**0.0003**	**2.41**	

No data of length-weight relationship is available for *Hippocampus hippocampus*. When we compare our result (b=2.47) with those given by VERDIELL-CUBEDO et al. (2006; b=2.91), there is a significant difference between the length-weight relationships for *H. guttulatus* of Mar Menor coastal lagoon (south-eastern Spain) and İzmir Bay (western Turkey). Length ranges given by VERDIELL-CUBEDO et al. (2006) for *H. guttulatus* were between 42 and 73mm, while they varied between 100 and 165mm in this study. Since the length ranges in both studies (VERDIELL-CUBEDO et al. 2006; and present study), do not overlap, the results are not comparable. For *H. hippocampus* and *H. guttulatus* no length-weight relationship information was available in FishBase (FROESE & PAULY, 2004). However, both Mediterranean seahorse species are listed as data deficient (DD; ver. 3.1, IUCN, 2001) indicating that more information is required. This listing also acknowledges that future research may show that another classification is appropriate making data on seahorses in general of great importance.

The length-weight relationship in fishes can be affected by a number of factors including season, habitat, gonad maturity, sex, diet and stomach fullness, health and preservation techniques and differences in the length ranges of the specimen caught (TESH, 1971; WOOTTON, 1998), which were not accounted for in the present study. Thus,

differences in length-weight relationships between this and other studies could potentially be attributed to the combination of one or more of the factors given above.

The members of the family Syngnathidae are among the most common species of shallow waters. The information gained in the present survey may enable fish biologists to derive weight estimates for the İzmir Bay syngnathids that are measured but not weighed. Consequently, the data presented here could serve for comparison with similar studies of bays, estuaries, and coastal lagoons of the Mediterranean, and could be of use when the pipefish and seahorse populations are subjected to commercial fishing, part of recovery programs, or other management and conservation activities.

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