Fishes of Great Bay , New Jersey

Larvae and Juveniles

Collected by Nightlighting

Technical Report

Fishes of Great Bay, New Jersey: Larvae and Juveniles Collected by Nightlighting

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ABSTRACT

Fishes were collected under lights at night from 1986 - 1992 at the Rutgers University Marine Station in Great Bay in southern New Jersey to enhance our understanding of the early life history stages for species using the estuary. Sampling effort was greatest during the spring and summer when 39% and 51%, respectively, of all collections were made. During this span of years over 3,500 representing 62 taxa from 40 families were collected with the majority of these from the spring and summer. All collections were dominated by small individuals (<110 mm TL). Metamorphosing individuals for several species were common components during most years. The dominant species were approximately evenly divided between species that spawned either in the study estuary or on the continental shelf. Some of the latter originated from the Middle Atlantic and South Atlantic bights. Two common species of eels in these collections (Anguilla rostrata, Conger oceanicus) originated from as far away as the Sargasso Sea. Several species were new or rarely collected in New Jersey. Thus, based on all of the above, collections under nightlights offer the opportunity to extend our understanding of the early life history of fishes in temperate estuaries as well as other systems.

INTRODUCTION

Many species of fishes respond positively to light and the nature of the response varies among species, as well as within species at different stages of ontogeny, reproductive condition, season and temperature (Woodhead 1966, Leis 1991). Because some species and life history stages are attracted to artificial light, deployed either submerged or above the water, researchers have used this response to collect a variety of early life history stages. Once attracted they can be collected by dip nets (Smith et al. 1987, Victor 1986, 1991), lift nets (Victor 1986, Smith et al. 1987, Choat et al. 1993, Rooker et al. 1996), purse seines (Wickham, 1971, Choat et al. 1993) and light traps (Doherty 1987, Thorrold 1992, 1993, Brogan 1994). These approaches often collect larger, later-stage larvae and pelagic juveniles (Choat et al. 1993, Gregory and Powles 1988, Thorrold 1992) that can avoid capture with other collecting techniques. Despite the wide application of light-assisted collecting techniques, the focus to date has largely been in tropical waters and to the best of our knowledge has not been applied in temperate areas including estuaries. The purpose of this paper is to provide a seasonal characterization of the fish species and their size composition as collected under nightlights in Great Bay, New Jersey during 1986 - 1992. This is part of a larger effort to determine the patterns of estuarine use for fishes especially during the period of metamorphosis and settlement (Able and Fahay in press).

MATERIAL AND METHODS

Study Site

The study was conducted in Great Bay at the Rutgers University Marine Field Station (RUMFS) boat basin (Fig. 1). The basin, which was dredged in 1991 and 1994, ranged from intertidal to 3.0 m in depth. The basin is fringed with salt marsh cordgrass (Spartina alterniflora) intermixed with brown (Fucus, Ascophyllum) and green (Ulva lactuca) algae and narrow intertidal mud flats. The semidiurnal tides in this system are approximately 1 m (Able et al. 1992). Water temperatures and salinities range from -0.1 - 25.2°C and 23.6 - 34.5 ppt, respectively, based on daily mid-day measurements at the mouth of the basin approximately 200 m from the primary collecting site (Able et al. 1992). Adjacent Great Bay is relatively unaltered and is surrounded, in large part, by extensive salt marshes, many of which are undisturbed (Psuty et al. 1993). A natural inlet (Little Egg) to the Atlantic Ocean is approximately 2 km from the boat basin.

Sampling Techniques

Pelagic early life history stages of fishes aggregating under stationary lights positioned above the water surface were collected from April 1986 to August 1992 (Table 1). The timing of sampling relative to time of night and tide was haphazard. Sampling seasons were defined as follows: winter (January - March), spring (April - June), summer (July - September), fall (October - December). Individuals attracted to the lights were typically

collected with small dip nets (0.3 mm mesh) although larger nets were occasionally used. All individuals were preserved in 10% formalin or 95% ethyl alcohol. Later they were identified and measured to the nearest millimeter total length (mm TL). For small specimens (<15 mm TL) measurements were made with an ocular micrometer. In some instances, individuals were collected live for laboratory experiments, especially Pseudopleuronectes americanus, Paralichthys dentatus, Pollachius virens, and Conger oceanicus, and lengths are not available for these specimens. Identification was to the lowest possible taxon. In the case of Menidia spp., which were very abundant and of very small size, many of these were identified to species but not all. Other collections from an adjacent creek (Fig 1C), indicated the dominant form is M. menidia but M. beryllina can also occur (Rountree and Able 1992, 1993).

RESULTS AND DISCUSSION

Sampling Effort

Sampling was conducted by a variety of individuals, on a time available basis, over seven years. Weather conditions, amount of incident light from moonlight (see Victor 1986, Robertson 1992), and tide stage varied among collections. As a result, these are qualitative estimates of composition and abundance. As a further example of the qualitative nature of these samples, one of the most abundant forms visible under the light, Menidia sp., was often ignored during sampling because if collected it would not have allowed enough time to sample the rarer forms. The duration of sampling was recorded for 99 of the 153 nights in which sampling occurred. For these nights, the mean duration of sampling was 1.4 hrs (range 0.2 - 8.5 hrs) with most lasting between 0.4 - 2.5 hrs. Sampling effort varied among and within years, but was typically greatest during the spring (39.4% of nights that collections were made) and summer (51.3%) with much less effort during the fall and winter (9.2%) (Table 1).

Size Composition

The individuals captured covered a relatively large size range but most were small (<110 mm TL), reflecting both that these small individuals were the focus of this study and that these were the dominant forms attracted to the lights (Fig. 2). For some species, the sizes were somewhat larger than those of individuals collected in plankton collections in a nearby marsh thoroughfare (Little Sheepshead Creek, Fig. 1) on night flood tides (Witting 1995, Witting at al. in prep.), even allowing for the difference in measurements (i.e. TL vs SL, Table 2).

The range of sizes captured varied with species (Fig. 3) but all appeared to be young-of-the-year. Some species (e.g. Menidia menidia, Strongylura marina) were represented by large size ranges and thus were available for much of the first year of life. Other species had narrow size ranges (Anguilla rostrata, Astroscopus guttatus, Chaetodon ocellatus,

Mugil curema) suggesting that they either entered the estuary at a discrete size and then left the water column to settle or became negatively phototaxic and thus unavailable to this sampling technique. For Chaetodon ocellatus, the narrow size range was probably the result of settlement shortly after arrival in the estuary (McBride and Able in press). The same is known to be true for Anguilla rostrata. The Mugil curema collected had probably just entered the estuary but they may not be attracted to light at larger sizes. We suspect that Astroscopus guttatus, of the size collected, are ready to settle because some of these individuals were exposed to sand substrate and were capable of burying (D. Witting, pers. observ.).

Species Composition

During the seven years of sampling over 3,500 individuals representing approximately 40 families and 62 taxa were collected (Table 3). This number of species represents approximately 18.4% of all the marine fishes previously reported in New Jersey waters from the estuary to the edge of the continental shelf (Able 1992) and 57.9% of the species reported from Great Bay (Able and Fahay in press). Of the species collected by nightlighting some were new to the New Jersey fish fauna (Able 1992, Fahay 1993). The single specimen of Gasterosteus wheatlandi was the first collection from this far south with the previous southernmost record off of Long Island (Cowen et al. 1991). Ophichthus gomesi and Decapterus macarellus were also previously unreported from New Jersey. Other species, from more southern waters, that have been considered to be rare (Able 1992) were also collected. These included young-of-the-year Albula vulpes and Scomberomorus maculatus. Pollachius virens, which originated from spawning off New Jersey (Morse et al. 1987, Able and Fahay in press) were often common and more abundant than indicated because they hovered at a distance from the light and were difficult to collect. Some relatively rare life history stages, such as the tholichthys stage of Chaetodon ocellatus were never collected in plankton nets but they occurred frequently in nightlight collections (Table 2). Metamorphosing individuals of other forms were often quite abundant in nightlight collections including glass eels of Anguilla rostrata, late leptocephali and glass eels of Conger oceanicus, "half-beak" stage of Strongylura marina, queremana stage of Mugil curema and Clupea harengus (Table 3, Fig. 3). All of these were among the most abundant, based on the percent frequency of occurrence (Table 3).

The composition of the fauna varied with season (Table 4). Species richness was greatest in the spring (34) and summer (50) with fewer species collected in the winter (11) and fall (4). The reduced species richness in the fall and winter may have been due to the reduced collecting effort at that time (Table 1). It is as likely that the more diverse fauna in the spring and summer was due to increased reproduction both in the estuary and on the continental shelf during this period and reduced overall abundance in the fall and winter as reflected in other sampling programs in the area (Szedlmayer and Able 1996, Able et al. 1996). The occurrence of many species varied with season as well (Table 4). During the winter and spring the occurrences of several species were the result of reproduction in the winter or early spring. These included Clupea harengus, Pseudopleuronectes americanus,

Scophthalmus aquosus, Ammodytes sp., Pollachius virens and Gasterosteus aculeatus. Dominant forms that occurred in the spring and summer included Menidia spp., Mugil curema, Syngnathus fuscus, Strongylura marina, and Anchoa mitchilli. The other seasons were represented by small numbers of a variety of forms (Table 4).

It is difficult to compare species composition between years because this may merely reflect the variation in sampling effort (Table 1) and differences in collecting efforts among individuals and research programs during different years. Several species, however, were common in most years such as Menidia spp., Anguilla rostrata, Conger oceanicus, Syngnathus fuscus, Strongylura marina and Mugil curema (Table 5).

The dominant components of the fauna collected during nightlighting differed from another long-term night time collection with plankton nets in the same estuary (Table 2). Of the 15 dominant forms collected by nightlighting only seven species were shared (Menidia sp., Syngnathus fuscus, Anguilla rostrata, Anchoa mitchilli, Clupea harengus, Pseudopleuronectes americanus, Ammodytes sp.). The remaining species (Strongylura marina, Mugil curema, Chaetodon ocellatus, Gasterosteus aculeatus, Fundulus majalis, Astroscopus guttatus, Hypsoblennius hentz, Conger oceanicus) were much more abundant in nightlight collections. The increased availability of some forms under the nightlights is also an advantage because these individuals can be collected in excellent condition and thus provide a source of animals for other studies as we have done previously (Witting and Able 1993, Witting and Able 1995, McBride and Able in press). Although the focus of these collections were fishes, a number of other taxa can be collected under nightlights including selected crustaceans such as Homarus americanus, Callinectes sapidus and Ovalipes ocellatus as well as an apparently diverse isopod fauna (K.W. Able unpubl. data).

The dominant components of the nightlight collections (Table 2) were also well represented in other extensive collections of juvenile fishes in the same estuary (Rountree and Able 1992, 1993; Szedlmayer and Able 1996; Able et al. 1996). Exceptions to this pattern included Astroscopus guttatus and Hypsoblennius hentz, which are cryptic forms that either bury in the substrate or associate with structure. These behaviors may make them difficult to collect and thus they may be underrepresented in our sampling, even though we have employed a variety of gear types across the range of most habitats.

The most frequently collected forms, i.e. those that occurred in >2% of all samples, were approximately evenly divided between those that spawned in the estuary (15 species) and those that spawned on the continental shelf (19 species) (Table 3). Strikingly, two of the more abundant forms Anguilla rostrata and Conger oceanicus (Table 3) originated from spawning in the Sargasso Sea (Miller and McCleave 1994, Miller 1995). Several other forms in the nightlight collections (Fig. 3) probably originated from the South Atlantic Bight, including Gymnothorax ocellatus, Chaetodon ocellatus (see McBride and Able in press), Mugil spp. and occasional pomacentrids and epinephaline serranids. This may be true of other forms as well when we are better able to define the spawning location for many of the other migratory forms that use Middle Atlantic Bight estuaries.

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Table 1. Summary of nightlight collections at Rutgers University Marine Field Station in Great Bay, New Jersey, April 1986-August 1992. See Figure 1 for sampling location.

Year	Season	Number of Nights Sampled	Duration of Sampling	Number of Individuals	Species	Families
1986		18	April - November	515	14	14
	Spring	8		199	13	12
	Summer	8		313	9	9
	Fall	2		3	2	2
1987		10	March - December	118	15	13
	Winter	1		3	3	3
	Spring	5		62	7	7
	Summer	3		53	8	7
	Fall	1		0	0	0
1988		16	March - August	236	17	17
	Winter	4		10	3	3
	Spring	4		19	6	6
	Summer	8		207	14	14
1989		31	April - November	416	22	19
	Spring	13		235	13	13
	Summer	15		157	15	13
	Fall	3		24	3	2

Table 1. (Cont'd)

Year	Season	Number of Nights Sampled	Duration of Sampling	Number of Individuals	Species	Families
1990		16	March - September	214	25	20
	Winter	1		19	4	4
	Spring	3		27	7	7
	Summer	12		168	18	15
1991		9	January - July	144	13	13
	Winter	1		19	4	4
	Spring	5		102	7	7
	Summer	3		23	5	5
1992		52	March - August	1893	43	31
	Winter	1		3	3	3
	Spring	22		1135	24	19
	Summer	29		755	33	27
Totals	Winter	8		54	11	10
	Spring	60		1779	31	24
	Summer	78		1676	48	35
	Fall	6		27	4	3
Grand Totals		152		3536	62	40

Table 2. Comparison of species composition and lengths for species collected under nightlights at RUMFS versus those collected with plankton net at nearby Little Sheepshead Creek (Witting 1995, Witting et al. in review). Species listed in order of most frequent occurrence in nightlight collections and in order of greatest average density from plankton net collections. Menidia spp. from nightlight collections were compared to Menidia menidia data from plankton net.

Species	Lengths (mm TL) from nightlight collections		Lengths (mm SL) from plankton net collections	
	Mean	Range	Mean	Range
Menidia sp.	30.8	4-124	29.2	2.5-126
Syngnathus fuscus	80.8	14-156	46.6	5.1-251
Anguilla rostrata	58.4	45-68	60.7	25-140
Strongylura marina	69.1	16-255	37.2	18-67
Mugil curema	31.4	22-35	16.8	12-21.5
Chaetodon ocellatus	19.9	17-22.5	Not collected	
Anchoa mitchilli	34.8	11-78	20.2	1.7-79
Clupea harengus	64.3	28-90	32.8	19.5-63
Gasterosteus aculeatus	21.4	15-58	30.8	12-69
Pseudopleuronectes americanus	7.0	4.5-9	6.7	2.7-115
Fundulus majalis	29.4	15-53	47.4	7.4-83
Astroscopus guttatus	18.3	12-31	10.7	3.7-23.5
Hypsoblennius hentz	15.9	11.5-35	9.0	5.9-12.8
Ammodytes sp.	22.3	10-89	18.4	4.5-203
Conger oceanicus	101.1	70-112	99.2	59-210

Table 3. Percent frequency of occurrence, mean and range of sizes (mean size not given if less than three specimens measured) of fishes collected under night lights at the Rutgers University Marine Field Station. Spawning areas are given (E=estuaries, C=continental shelf-either MAB=Middle Atlantic Bight or SAB=South Atlantic Bight, F=freshwater, and SS=Sargasso Sea), based on the literature source indicated.

Scientific Name	Common Name	Frequency of Occurrence	Size (mm TL) Mean	Size (mm TL) Min-Max	Spawning Area	Literature Source
Albuliformes						
Albulidae						
Albula vulpes	Bonefish	<1.0	---	60	C-SAB	---
Anguilliformes						
Anguillidae						
Anguilla rostrata	American eel	21.7	58.4	45-68	SS	Miller and McCleave 1994
Muraenidae						
Gymnothorax ocellatus complex	Moray eel	<1.0	---	80	C-SAB	---
Ophichthidae						
Ophichthus gomesi	Shrimp eel	2.0	78.3	70-83	?	---
Congridae						
Conger oceanicus	Conger eel	6.6	101.1	70-112	SS	McCleave and Miller 1994
Clupeiformes						
Clupeidae						
Alosa pseudoharengus	Alewife	<1.0	---	70	F	Mayo 1982
Brevoortia tyrannus	Atlantic menhaden	4.6	22.9	13-32	EC-MAB&SAB	Kendall and Reintjes 1975, Warlen et al. in press
Clupea harengus	Atlantic herring	10.5	64.3	28-90	C-MAB	Bigelow and Schroeder 1953
Engraulidae						
Anchoa mitchilli	Bay anchovy	12.5	34.8	11-78	EC-MAB	Vouglitois et al. 1987
Engraulis eurystole	Silver anchovy	<1.0	38.5	36-42	?	---
Aulopiformes						
Synodontidae						
Synodus foetens	Inshore lizardfish	5.9	35.0	20-45	?	---
Gadiformes						
Gadidae						

Table 3. (Cont'd)

Scientific Name	Common Name	Frequency of Occurrence	Size (mm TL) Mean	Size (mm TL) Min-Max	Spawning Area	Literature Source
Enchelyopus cimbrius	Fourbeard rockling	2.0	33.4	9-45	C-MAB	Able and Hagan 1995
Pollachius virens	Pollock	3.3	---	---	C-MAB	
Ophidiidae						
Ophidion sp.	Cusk-eel	1.3	---	22.1	?	
Atheriniformes						
Exocoetidae						
Hyporamphus meeki		<1.0	---	6	?	
Belonidae						
Strongylura marina	Atlantic needlefish	17.8	69.1	16-255	E	
Cyprinodontidae						
Cyprinodon variegatus	Sheepshead minnow	2.0	28.6	21-42	E	Able 1990
Fundulus heteroclitus	Mummichog	1.3	---	21-22	E	Able 1990
Fundulus majalis	Striped killifish	7.9	29.4	15-53	E	pers. observ.
Atherinidae						
Membras martinica	Rough silverside	<1.0	---	96	?	
Menidia sp.	Atlantic/Tidewater silverside	44.7	30.8	4-124	E	Conover and Kynard 1984
Gasterosteiformes						
Gasterosteidae						
Gasterosteus aculeatus	Threespine stickleback	9.9	21.4	15-58	E	pers. observ.
Gasterosteus wheatlandi	Blackspotted stickleback	<1.0	---	38	E	
Syngnathidae						
Hippocampus erectus	Lined seahorse	2.0	71.5	66-75	E	Pers. observ.
Syngnathus fuscus	Northern pipefish	29.6	80.8	14-156	E	Lazzari and Able 1990
Scorpaeniformes						
Scorpaenidae	Scorpionfishes	<1.0	---	17	?	
Triglidae						
Prionotus carolinus	Northern searobin	<1.0	---	110	E, C-MAB	McBride and Able 1994
Prionotus evolans	Striped searobin	3.3	21.3	16-31	E, C-MAB	McBride and Able 1994
Cottidae						
Myoxocephalus aenaeus	Grubby	2.6	11.2	6-13	E, C-MAB	Morrow 1951

Table 3. (Cont'd)

Scientific Name	Common Name	Frequency of Occurrence	Size (mm TL) Mean	Size (mm TL) Min-Max	Spawning Area	Literature Source
Perciformes						
Epinephelinae (Serranidae?)	Groupers	1.3	---	---	C-SAB	
Pomatomidae						
Pomatomus saltatrix	Bluefish	3.3	18.2	10.5-82	C-MAB&SAB	Kendall and Walford 1979
Carangidae						
Caranx crysos	Blue runner	<1.0	---	35-37	?	
Caranx hippos	Crevalle jack	<1.0	---	38	C-SAB	Berry 1959
Decapterus macarellus	Mackerel scad	<1.0	---	93	?	
Seriola zonata	Banded rudderfish	3.3	71.3	47-123	?	
Trachinotus falcatus	Permit	1.3	---	21	?	
Gerreidae	Mojarra family	1.3	---	13	?	
Sciaenidae						
Menticirrhus saxatilis	Northern kingfish	3.9	20.8	15-35	C-MAB	Able and Hagan 1995
Chaetodontidae						
Chaetodon ocellatus	Spotfin butterflyfish	12.5	19.9	17-22.5	C-SAB	McBride and Able in press
Pomacentridae	Damselfish family	2.0	---	17-19	C-SAB?	
Mugilidae						
Mugil cephalus	Striped mullet	<1.0	---	29	C	Powles 1981
Mugil curema	White mullet	16.4	31.4	22-35	C-SAB	Powles 1981
Mugil sp.		<1.0	---	28	---	
Sphyraenidae						
Sphyraena borealis	Northern sennet	3.3	100	59-160	C	Houde 1972
Labridae						
Tautoga onitis	Tautog	2.6	30.2	11-60	EC	Sogard et al. 1992
Tautogolabrus adspersus	Cunner	<1.0	---	23	EC	
Pholidae						
Pholis gunnellus	Rock gunnel	2.0	28.8	25-32	?	
Uranoscopidae						
Astroscopus guttatus	Northern stargazer	7.2	18.3	12-31	?	
Blenniidae						

Table 3. (Cont'd)

Scientific Name	Common Name	Frequency of Occurrence	Size (mm TL) Mean	Size (mm TL) Min-Max	Spawning Area	Literature Source
Hypsoblennius hentz	Feather blenny	7.2	15.9	11.5-35	?	
Ammodytidae						
Ammodytes sp.	Sandlance	7.2	22.3	10-89	?	
Gobiidae	Goby family	2.0	19.1	13-23	?	
Scombridae						
Scomber japonicus	Chub mackerel	<1.0	---	90	?	
Scomber scombrus	Atlantic mackerel	<1.0	---	19-21	C-MAB	Able and Hagan 1995
Scomberomorus maculatus	Spanish mackerel	2.6	21.5	10-35	C	
Stromateidae						
Peprilus triacanthus	Butterfish	<1.0	---	11	C-MAB	Bigelow and Schroeder 1953
Pleuronectiformes						
Bothidae						
Bothus sp.	Eyed/Spottail flounder	<1.0	---	24	?	
Etropus microstomus	Smallmouth flounder	2.6	16.3	15-17	C	Richardson and Joseph 1973
Paralichthys dentatus	Summer flounder	2.6	12.1	11.4-13	C-MAB	Able et al. 1990
Paralichthys oblongus	Fourspot flounder	<1.0	---	24-25	C-MAB	Smith et al. 1975
Scophthalmus aquosus	Windowpane	5.3	9.4	6.2-32	EC-MAB	Morse and Able 1995
Pleuronectidae						
Pseudopleuronectes americanus	Winter flounder	9.2	7.0	4.5-9	E	Pearcy 1962
Tetraodontiformes						
Balistidae						
Monocanthus hispidus	Planehead filefish	<1.0	---	38	?	
Tetraodontidae						
Sphoeroides maculatus	Northern puffer	3.3	57.6	12-228	E	Nichols and Breder 1927

Table 4. Seasonal species composition, percent frequency of occurrence, approximate abundance and size of larval and juvenile fishes collected by nightlighting from 1986-1992 (abundances in parentheses indicate actual number of individuals measured, when different from that collected).

Season	Frequency of occurrence	Number of Individuals	Size (in mm TL)	
			Mean	Min-Max
Winter				
Anguilla rostrata	50.0	11(8)	59.9	52-68
Gasterosteus aculeatus	50.0	4(2)	---	18-58
Brevoortia tyrannus	25.0	8	21.9	18-29
Menidia sp.	25.0	4(2)	---	72-75
Pseudopleuronectes americanus	25.0	2	---	6-7
Clupea harengus	12.5	2	---	28-32
Fundulus majalis	12.5	1	---	40
Myoxocephalus aenaeus	12.5	1	---	12
Mugil sp.	12.5	1	---	28
Ammodytes sp.	12.5	5	19.0	14-24
Paralichthys dentatus	12.5	15	---	---
Spring				
Menidia sp.	38.3	319(141)	16.6	4-72
Anguilla rostrata	31.7	63(58)	58.2	45-65
Clupea harengus	25.0	253	64.5	39-90
Mugil curema	23.3	84	31.8	23-35
Pseudopleuronectes americanus	20.0	599(29)	7.0	4.5-9.0
Gasterosteus aculeatus	16.7	14(11)	18.3	15-20
Ammodytes sp.	15.0	100(80)	21.7	10-57
Conger oceanicus	11.7	35(23)	103.3	93-112
Syngnathus fuscus	11.7	52	54.8	17-103
Scophthalmus aquosus	10.0	53(30)	8.3	6.2-22
Pollachius virens	8.3	69(1)	---	40
Strongylura marina	8.3	10	34.6	20-53
Anchoa mitchilli	6.7	8	60.1	41-78
Brevoortia tyrannus	5.0	4	27.8	26-32
Synodus foetens	5.0	11(9)	35	33-38
Hippocampus erectus	5.0	4	71.5	66-75
Myoxocephalus aenaeus	5.0	24	11.2	6-13
Pholis gunnellus	5.0	4	28.8	25-32

Table 4. (Cont'd)

Season	Frequency of occurrence	Number of Individuals	Size (in mm TL)	
			Mean	Min-Max
Paralichthys dentatus	5.0	16(7)	12.1	11.4-13
Enchelyopus cimbrius	3.3	6	32.8	9-45
Epinephelinae	3.3	2	---	---
Seriola zonata	3.3	2(1)	---	47
Chaetodon ocellatus	3.3	2(1)	---	21
Alosa pseudoharengus	1.7	1	---	70
Cyprinodon variegatus	1.7	2	---	21-23
Fundulus majalis	1.7	4	21.3	15-25
Gasterosteus wheatlandi	1.7	1	---	38
Prionotus carolinus	1.7	1	---	110
Pomatomus saltatrix	1.7	29	13.1	10.5-15.5
Mugil cephalus	1.7	1	---	29
Sphyraena borealis	1.7	1	---	59
Scomber scombrus	1.7	2	---	19-21
Scomber sp.	1.7	1	---	45
Sphoeroides maculatus	1.7	1	---	228
Unidentified larvae	1.7	1	---	16
Summer				
Menidia sp.	52.6	915(596)	34.6	11-124
Syngnathus fuscus	48.7	200	87.1	12-156
Strongylura marina	28.2	111(104)	72.5	16-255
Chaetodon ocellatus	21.8	26(22)	19.9	17-22.5
Anchoa mitchilli	16.7	133(92)	32.2	11-68
Mugil curema	14.1	22(21)	29.8	22-34
Astroscopus guttatus	14.1	45(38)	18.3	12-31
Hypsoblennius hentz	14.1	22	15.9	11.5-35
Anguilla rostrata	12.8	11	58.4	53-63
Fundulus majalis	12.8	17	30.6	18-53
Synodus foetens	7.7	30(9)	35.0	20-45
Menticirrhus saxatilis	7.7	12	20.8	15-35
Prionotus evolans	6.4	6	21.3	16-31
Pomatomus saltatrix	5.1	33(3)	67.3	60-82
Sphyraena borealis	5.1	5(4)	110.3	59-160
Tautoga onitis	5.1	6	30.2	11-60
Scomberomorus maculatus	5.1	4	21.5	10-35

Table 4. (Cont'd)

Season	Frequency of occurrence	Number of Individuals	Size (in mm TL)	
			Mean	Min-Max
Etropus microstomus	5.1	5(3)	16.3	15-17
Sphoeroides maculatus	5.1	4	15.0	12-19
Ophichthus gomesi	3.8	4	78.3	70-83
Conger oceanicus	3.8	5	90.8	70-104
Caranx sp.	3.8	3(1)	---	39
Seriola zonata	3.8	4(3)	79.3	53-123
Pomacentridae	3.8	4(2)	---	17-19
Gobiidae	3.8	7	19.1	13-23
Ophidion sp.	2.6	3(1)	---	22.1
Cyprinodon variegatus	2.6	3	33.0	27-42
Fundulus heteroclitus	2.6	2	---	21-22
Trachinotus falcatus	2.6	2(1)	---	21
Gerreidae	2.6	2	---	13-13
Scophthalmus aquosus	2.6	4	17.8	8-34
Albula vulpes	1.3	1	---	60
Gymnothorax ocellatus complex	1.3	1	---	80
Engraulidae	1.3	1	---	14
Enchelyopus cimbrius	1.3	1	---	37
Hyporamphus meeki	1.3	1	---	6
Fundulus sp.	1.3	4	---	---
Membras martinica	1.3	1	---	96
Gasterosteus aculeatus	1.3	1	---	23
Scorpaenidae	1.3	1	---	17.0
Caranx crysos	1.3	2	---	35-37
Caranx hippos	1.3	1	---	38
Decapterus macarellus	1.3	1	---	93
Tautogolabrus adspersus	1.3	1	---	23
Ammodytes sp.	1.3	1	---	89
Scomber japonicus	1.3	1	---	90
Peprilus triacanthus	1.3	1	---	11
Bothus sp.	1.3	1	---	24
Paralichthys oblongus	1.3	2	---	24-25
Monocanthus hispidus	1.3	1	---	38
Unidentified larvae	1.3	2	---	8-9.5

Table 4. (Cont'd)

Season	Frequency of occurrence	Number of Individuals	Size (in mm TL)	
			Mean	Min-Max
Fall				
Anchoa mitchilli	33.3	8	40.1	36-51
Menidia sp.	33.3	3	49.0	43-57
Brevoortia tyrannus	33.3	2	---	13-21
Engraulis eurystole	16.7	14	38.5	36-42

Table 5. Annual species composition, percent frequency of occurrence (Freq), and number of individuals (n) for spring and summer nightlight collections combined for 1986-1992.

Species	1986		1987		1988		1989		1990		1991		1992	
	Freq	n	Freq	n	Freq	n	Freq	n	Freq	n	Freq	n	Freq	n
Albula vulpes	---	---	---	---	---	---	---	---	---	---	---	---	2.0	1
Anguilla rostrata	50.0	9	---	---	16.7	3	25.0	33	6.7	1	25.0	2	17.6	26
Gymnothorax ocellatus complex	---	---	---	---	---	---	---	---	---	---	---	---	2.0	1
Ophichthus gomesi	---	---	---	---	---	---	---	---	---	---	---	---	5.9	4
Conger oceanicus	6.3	9	25.0	2	16.7	3	7.1	20	---	---	---	---	5.9	6
Alosa pseudoharengus	---	---	---	---	---	---	---	---	6.7	1	---	---	---	---
Brevoortia tyrannus	6.3	1	---	---	---	---	---	---	---	---	---	---	3.9	3
Clupea harengus	---	---	50.0	12	---	---	---	---	---	---	---	---	21.6	241
Anchoa mitchilli	12.5	7	25.0	2	25.0	75	25.0	51	---	---	---	---	5.9	6
Engraulidae	---	---	---	---	---	---	3.6	1	---	---	---	---	---	---
Synodus foetens	---	---	---	---	---	---	10.7	11	13.3	22	---	---	7.8	8
Enchelyopus cimbrius	---	---	---	---	---	---	---	---	6.7	4	---	---	3.9	3
Pollachius virens	6.3	2	---	---	---	---	---	---	---	---	12.5	1	5.9	66
Ophidion sp.	---	---	---	---	---	---	---	---	13.3	3	---	---	---	---

Table 5. (Cont'd)

Species	1986		1987		1988		1989		1990		1991		1992	
	Freq	n	Freq	n	Freq	n	Freq	n	Freq	n	Freq	n	Freq	n
Hyporamphus meeki	---	---	12.5	1	---	---	---	---	---	---	---	---	---	---
Strongylura marina	6.3	1	12.5	10	16.7	6	7.1	6	40.0	65	37.5	4	23.5	29
Cyprinodon variegatus	---	---	12.5	2	---	---	---	---	---	---	---	---	3.9	3
Fundulus heteroclitus	---	---	12.5	1	---	---	---	---	---	---	---	---	2.0	1
Fundulus majalis	6.3	1	---	---	16.7	2	---	---	13.3	5	---	---	11.8	13
Fundulus sp.	6.3	4	---	---	---	---	---	---	---	---	---	---	---	---
Membras martinica	---	---	---	---	---	---	---	---	---	---	---	---	2.0	1
Menidia sp.	62.5	427	75.0	78	66.7	100	25.0	105	33.3	34	25.0	83	51.0	407
Gasterosteus aculeatus	6.3	1	12.5	3	33.3	4	---	---	---	---	12.5	2	7.8	5
Gasterosteus wheatlandi	---	---	---	---	---	---	---	---	---	---	---	---	2.0	1
Hippocampus erectus	---	---	---	---	---	---	---	---	---	---	---	---	5.9	4
Syngnathus fuscus	6.3	1	12.5	1	16.7	2	21.4	16	20.0	8	12.5	1	60.8	223
Scorpaenidae	---	---	---	---	---	---	---	---	---	---	---	---	2.0	1
Prionotus carolinus	---	---	---	---	---	---	---	---	---	---	---	---	2.0	1
Prionotus evolans	---	---	---	---	---	---	---	---	6.7	1	---	---	7.8	5

Table 5. (Cont'd)

Species	1986		1987		1988		1989		1990		1991		1992	
	Freq	n	Freq	n	Freq	n	Freq	n	Freq	n	Freq	n	Freq	n
Myoxocephalus aenaeus	---	---	---	---	---	---	3.6	5	---	---	---	---	3.9	19
Epinephelinae	6.3	1	---	---	---	---	---	---	---	---	12.5	1	---	---
Pomatomus saltatrix	---	---	---	---	16.7	2	---	---	6.7	30	12.5	29	2.0	1
Caranx crysos	---	---	---	---	---	---	---	---	---	---	---	---	2.0	2
Caranx hippos	---	---	---	---	8.3	1	---	---	---	---	---	---	---	---
Caranx sp.	6.3	1	---	---	---	---	7.1	2	---	---	---	---	---	---
Decapterus macarellus	---	---	---	---	---	---	3.6	1	---	---	---	---	---	---
Seriola zonata	6.3	1	---	---	---	---	---	---	---	---	---	---	7.8	5
Trachinotus falcatus	---	---	---	---	---	---	3.6	1	6.7	1	---	---	---	---
Gerreidae	---	---	---	---	---	---	7.1	2	---	---	---	---	---	---
Menticirrhus saxatilis	---	---	---	---	---	---	3.6	1	---	---	---	---	9.8	11
Chaetodon ocellatus	6.3	1	---	---	---	---	14.3	4	20.0	6	---	---	21.6	17
Pomacentridae	---	---	---	---	---	---	---	---	---	---	---	---	5.9	4
Mugil cephalus	6.3	1	---	---	---	---	---	---	---	---	---	---	---	---
Mugil curema	37.5	23	12.5	1	8.3	4	17.9	5	6.7	1	---	---	21.6	72

Table 5. (Cont'd)

Species	1986		1987		1988		1989		1990		1991		1992	
	Freq	n	Freq	n	Freq	n	Freq	n	Freq	n	Freq	n	Freq	n
Sphyraena borealis	---	---	12.5	1	---	---	7.1	3	---	---	12.5	1	2.0	1
Tautoga onitis	6.3	1	---	---	16.7	4	---	---	6.7	1	---	---	---	---
Tautogolabrus adspersus	---	---	---	---	---	---	---	---	6.7	1	---	---	---	---
Pholis gunnellus	---	---	---	---	---	---	---	---	---	---	---	---	5.9	4
Astroscopus guttatus	---	---	---	---	8.3	3	---	---	6.7	4	---	---	17.6	38
Hypsoblennius hentz	---	---	---	---	---	---	---	---	---	---	---	---	19.6	22
Ammodytes sp.	---	---	---	---	8.3	9	14.3	29	---	---	---	---	9.8	63
Gobiidae	---	---	12.5	1	16.7	6	---	---	---	---	---	---	---	---
Scomber japonicus	---	---	---	---	---	---	---	---	6.7	1	---	---	---	---
Scomber scombrus	---	---	---	---	---	---	---	---	6.7	2	---	---	---	---
Scomber sp.	---	---	---	---	---	---	3.6	1	---	---	---	---	---	---
Scomberomorous maculatus	---	---	---	---	8.3	1	7.1	2	6.7	1	---	---	---	---
Peprilus triacanthus	---	---	---	---	---	---	3.6	1	---	---	---	---	---	---
Bothus *sp.*	---	---	---	---	---	---	---	---	6.7	1	---	---	---	---
Etropus microstomus	---	---	---	---	---	---	---	---	6.7	2	---	---	5.9	3

Table 5 (Con't.)

Species	1986		1987		1988		1989		1990		1991		1992	
	Freq	n	Freq	n	Freq	n	Freq	n	Freq	n	Freq	n	Freq	n
Paralichthys dentatus	---	---	---	---	---	---	---	---	---	---	---	---	5.9	16
Paralichthys oblongus	---	---	---	---	---	---	---	---	---	---	---	---	2.0	2
Scophthalmus aquosus	---	---	---	---	---	---	10.7	50	---	---	---	---	9.8	7
Pseudopleuronectes americanus	12.5	20	---	---	8.3	1	14.3	40	---	---	---	---	9.8	538
Monocanthus hispidus	---	---	---	---	---	---	---	---	---	---	12.5	1	---	---
Sphoeroides maculatus	---	---	---	---	---	---	---	---	---	---	---	---	9.8	5
Unidentified larvae	---	---	---	---	---	---	3.6	2	---	---	---	---	2.0	1

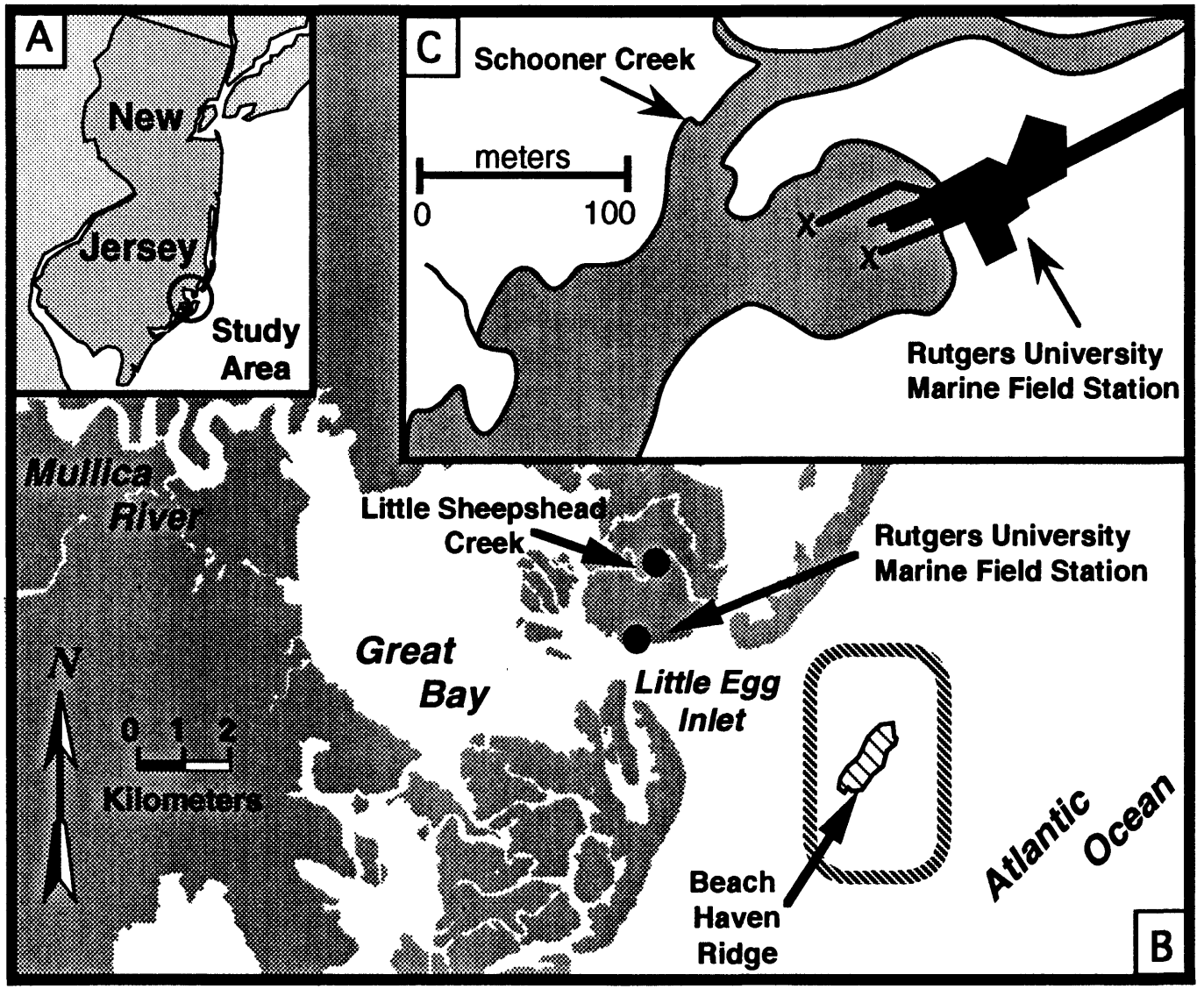

Figure 1. Sampling location in southern New Jersey (A) in the vicinity of lower Great Bay (B). X = indicates primary sampling location in the Rutgers University Marine Field Station boat basin (C).

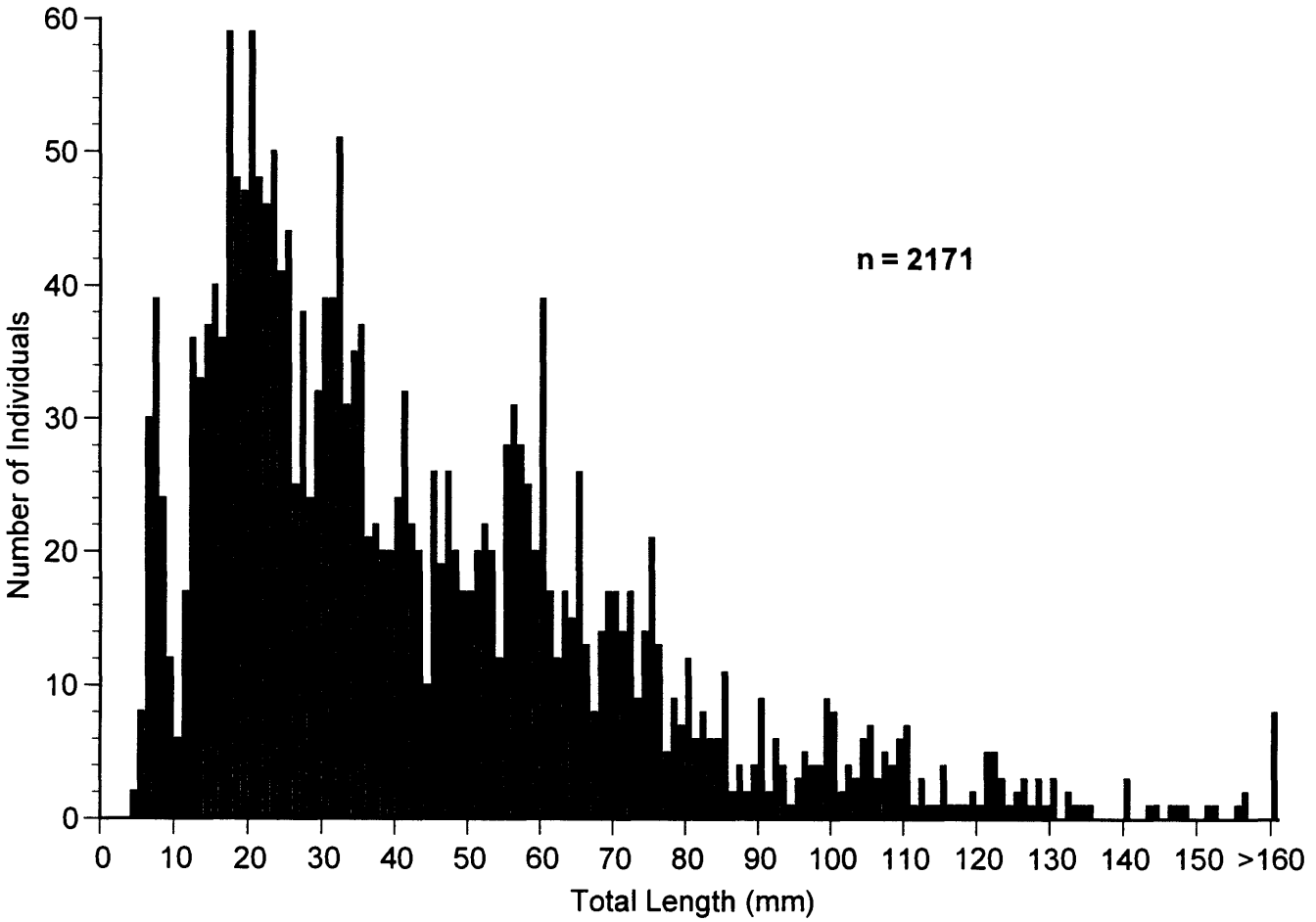

Figure 2. Composite length frequency for individuals collected by nightlighting.

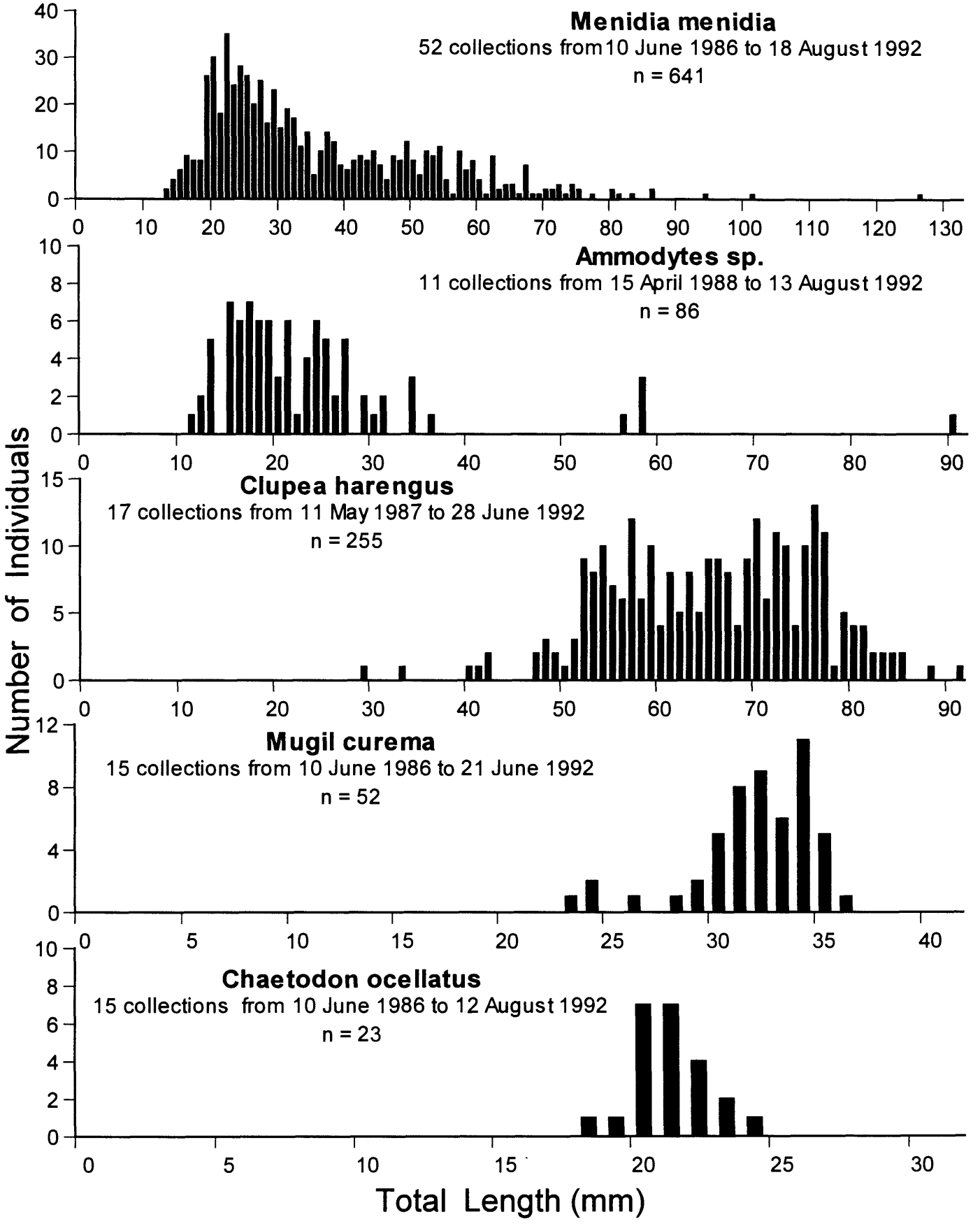

Figure 3. Composite length frequency for selected species collected by nightlighting at RUMFS.

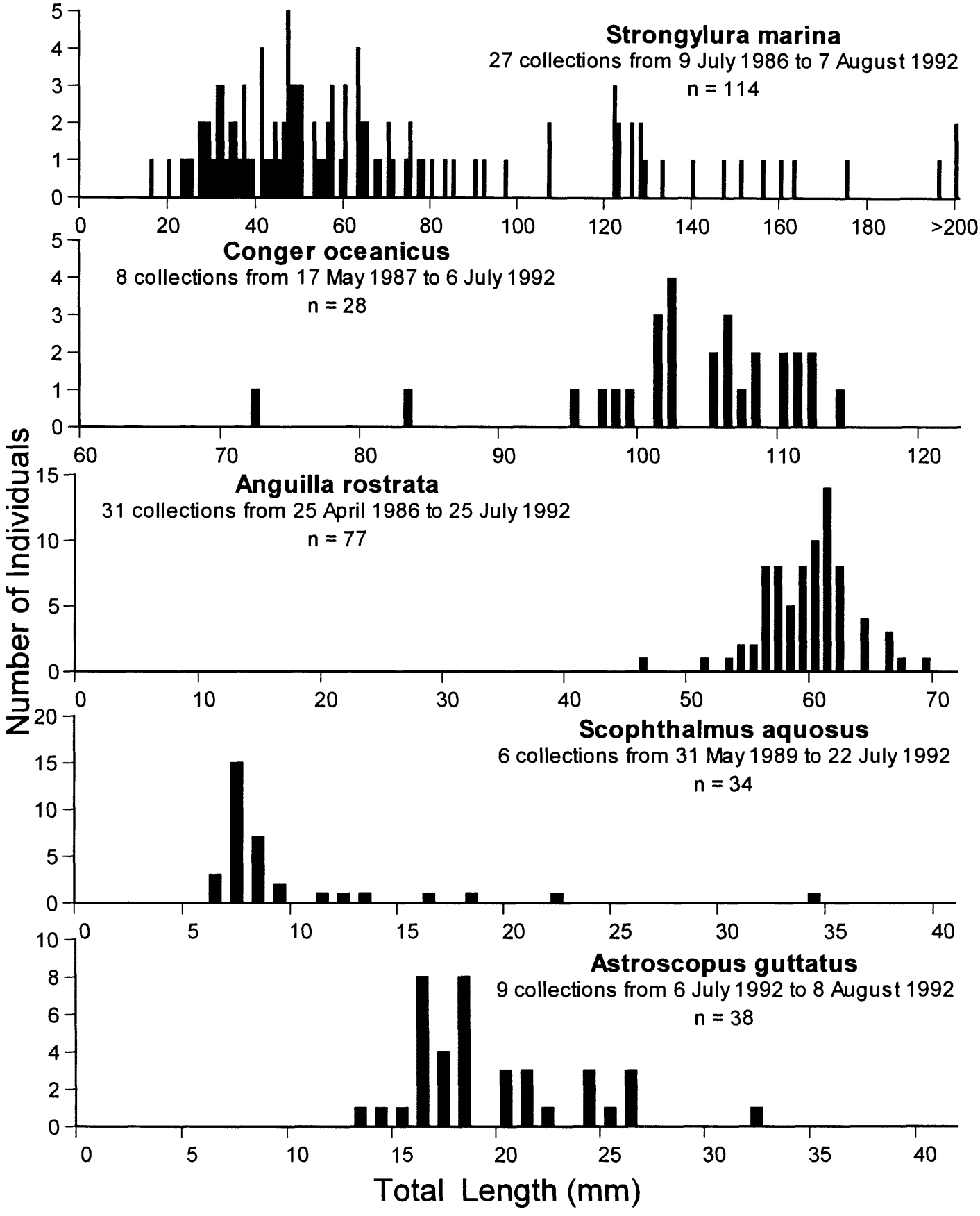

Figure 3 (cont'd). Composite length frequency for selected species collected by nightlighting at RUMFS.