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# *Ammodytoides pylei*, a New Species of Sand Lance (Ammodytidae) from the Hawaiian Islands[1]

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ABSTRACT: A new sand lance, *Ammodytoides pylei*, is described from 17 specimens collected on sand substratum in the depth range of 7 to 120 m from Molokai to the Ladd Seamount in the Northwestern Hawaiian Islands. It is characterized by 48–52 dorsal rays, 22–25 anal rays, 15–17 pectoral rays, 109–116 lateral-line scales, 29–33 gill rakers, 59–60 vertebrae, an elongate body (depth 8.5–10 in standard length [SL]), and a series of small blackish spots at the margin of the dorsal fin. The spawning behavior is described.

WHILE DIVING off Kahe Point, Oahu, on 18 November 1988, J.L.E. encountered a school of about 80 slender, silvery white fish of a species unknown to him. The fish, ca. 150 mm in total length, were moving rapidly over sand bottom at a depth of 8–9 m. Spawning was observed at this time (see *Remarks* below). J.L.E. returned the next day to the site, accompanied by J.E.R., Richard L. Pyle, and Jane B. Culp, with the intention of obtaining specimens by spearing or hand net. The fish could not be approached closely enough to be collected, but they were recognized as an ammodytid (common name for the family, sand lance).

Gosline and Brock (1960: 239) recorded the ammodytid *Bleekeria gilli* Bean from the Hawaiian Islands from two specimens about 75 mm long. The specimen they examined "was taken from aku (*Katsuwonus pelamis*) spewings," hence was probably a postlarval fish. The Bishop Museum has a specimen, BPBM 3416, 76 mm SL, from Pearl and Hermes Reef in the Northwestern Hawaiian Islands reported as *Bleekeria gilli* by Fowler and Ball (1925). The Museum also has four adult specimens in poor condition that were collected with a Clinton sled by personnel of the Honolulu Laboratory of the National Marine Fisheries Service in 1972 from a depth of 120 m in the Kaiwi Channel off Molokai. In addition, there are five lots of postlarvae, 25–50 mm in standard length, taken with a neuston net at the surface and by a Cobb trawl at 50–100 m. We wondered if the adult sand lances we were seeing in shallow water were the same species as the above-mentioned specimens.

On a subsequent dive an attempt was made to collect the Kahe Point sand lances by firing a power head into the sand near the fish. The sand proved to be too yielding to provide enough impact to fire the shell. This problem was solved by gluing a coin to the front of the shell. To our astonishment, a blast in close proximity did not even stun the fish, although a few darted into the sand. Later it was determined that this species lacks a gas bladder and hence is resistant to an explosion. On 20 November six divers surrounded a school and caused the fish to take refuge in the sand. A net was quickly laid over them, and one was gilled as it tried to leave the sand. At a later date Pyle, Culp, and Arnold Y. Suzumoto collected five specimens, including the holotype. Still later, J.E.R. and J.L.E. obtained two more specimens at the island of Kauai with diver colleagues. Examination of the specimens revealed them to be conspecific with the older Bishop Museum material. None, however, are *Bleekeria gilli*; they represent an undescribed species.

While the authors were conducting field-

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work together in the Ogasawara Islands in 1991, J.E.R. and J.L.E. learned that H.I. had obtained five adult specimens of the same ammodytid. His specimens were collected in 1973 by trawling from the R.V. *Kaiyo Maru* on Ladd Seamount, northwest of Pearl and Hermes Reef in the Northwestern Hawaiian Islands, at a depth of 77 m. When we determined that these specimens were the same species as those from the main Hawaiian Islands, we decided to describe the fish together. In a review of the Ammodytidae, Ida, Sirimontaporn, and Monkolprasit (unpublished data) have classified this species in *Ammodytoides* Duncker & Mohr (1939), which they regard as distinct from *Bleekeria*. We concur with this placement.

## MATERIALS AND METHODS

Type specimens of the new species have been deposited in the Bernice P. Bishop Museum, Honolulu (BPBM); School of Fisheries, Kitasato University, Iwate Prefecture (FSKU); Natural History Museum of Los Angeles County (LACM); Museum National d'Histoire Naturelle, Paris (MNHN); National Science Museum, Tokyo (NSMT); and U.S. National Museum of Natural History, Washington, D.C. (USNM). Although the five lots of postlarvae mentioned above are identified as the new species, they are not listed as paratypes. The holotype of *Ammodytoides vaga* (McCulloch & Waite) was examined at the Australian Museum, Sydney (AMS).

Lengths recorded for type specimens are standard length (SL), which is measured from the front of the upper lip in the median plane to the midbase of the caudal fin (end of hypural plate). Body depth is the maximum depth from the base of the dorsal fin to the ventralmost edge of the abdomen. Body width is the greatest width. Head length is taken from the front of the upper lip to the posterior end of the opercular membrane. Orbit diameter is the maximum fleshy diameter (measured to edges of the adipose eyelid); interorbital width is the least fleshy width. Caudal peduncle depth is the least depth, and caudal peduncle length the horizontal distance between verticals at the rear base of the anal fin and the caudal-fin base. Length of fin rays is measured to their extreme bases. Caudal-fin length is measured horizontally from the caudal-fin base to a vertical at the tip of the longest caudal-fin lobe; caudal concavity is the horizontal distance between verticals at the tips of the longest and shortest caudal-fin rays. Gill-raker counts include rudiments; the raker at the angle is included in the lower-limb count. Vertebral counts include the hypural.

Data in parentheses in the following description refer to paratypes. Proportional measurements of the holotype and nine of the paratypes are given in Table 1; the paratypes are arranged in ascending order according to length. Proportions in the text are expressed as follows: body depth and head length are divided into the standard length, body width into the depth, and the remaining measurements into the head length. These ratios are rounded to the nearest 0.05.

*Ammodytoides pylei* Randall, Ida & Earle, n. sp.

Figures 1, 2*A*, 3; Table 1

*Bleekeria gillii* (*non* Bean), Fowler & Ball, 1925:27; Fowler, 1928:426, fig. 70 (Pearl and Hermes Reef; error for *gilli*).

*Bleekeria gillii* (*non* Bean), Gosline & Brock, 1960:239 (Hawaiian Islands; error for *gilli*).

DIAGNOSIS: A species of *Ammodytoides* with dorsal rays 48–52; anal rays 22–25; pectoral rays 15–17; lateral-line scales 109–116; a row of small scales on upper edge of opercle; gill rakers 5–7 + 23–27; vertebrae 59–60; body depth 8.5–10 in SL; silvery white with a row of small blackish spots at or near edge of dorsal fin.

DESCRIPTION: Dorsal rays 49 (48–52), the first two rays simple; anal rays 23 (22–25), the first three rays simple; pectoral rays 15 (15–17), the upper two and lowermost rays simple; no pelvic fins (but pelvic girdle present); principal caudal rays 15 (8 + 7, of which 7 + 6 branched); upper and lower procurrent caudal rays 9; fin rays segmented

TABLE 1

PROPORTIONAL MEASUREMENTS OF TYPE SPECIMENS OF *Ammodytoides pylei* EXPRESSED AS A PERCENTAGE OF THE STANDARD LENGTH

| | HOLOTYPE | PARATYPES | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| PARAMETERS | BPBM 33923 | NSMT P 35112 | BPBM 34913 | BPBM 33498 | MNHN 1992-1 | BPBM 34915 | LACM 45516-1 | USNM 316514 | NSMT P 35113 | NSMT P 35114 |
| Standard length (mm) | 142 | 93.2 | 98.6 | 117.0 | 123.1 | 128.2 | 131.8 | 137.0 | 156.8 | 167.5 |
| Body depth | 11.3 | 10.0 | 10.7 | 10.9 | 10.3 | 11.7 | 11.3 | 10.7 | 10.1 | 10.3 |
| Body width | 8.3 | 7.5 | 8.3 | 8.8 | 8.2 | 9.5 | 8.7 | 8.2 | 7.2 | 8.3 |
| Head length | 22.6 | 24.6 | 24.4 | 23.0 | 22.7 | 22.2 | 22.8 | 22.0 | 22.8 | 22.5 |
| Snout length | 7.0 | 7.0 | 6.9 | 7.0 | 6.6 | 6.8 | 6.8 | 6.4 | 6.9 | 6.5 |
| Orbit diameter | 3.1 | 3.7 | 3.5 | 3.3 | 3.1 | 3.0 | 2.9 | 2.9 | 3.0 | 2.9 |
| Interorbital space | 4.1 | 3.7 | 4.0 | 4.1 | 3.7 | 4.1 | 4.0 | 3.8 | 3.5 | 3.6 |
| Upper jaw length | 7.1 | 7.9 | 7.8 | 7.5 | 6.8 | 6.6 | 7.0 | 6.6 | 7.0 | 6.7 |
| Caudal peduncle depth | 4.8 | 5.2 | 5.1 | 4.9 | 4.6 | 4.6 | 4.6 | 4.5 | 4.5 | 4.6 |
| Caudal peduncle length | 11.2 | 10.8 | 11.1 | 12.0 | 11.2 | 11.1 | 11.5 | 11.6 | 10.6 | 10.6 |
| Predorsal length | 23.2 | 24.5 | 24.7 | 24.5 | 23.1 | 21.8 | 24.1 | 22.9 | 23.2 | 23.0 |
| Preanal length | 66.1 | 64.5 | 63.8 | 65.1 | 64.5 | 64.6 | 64.7 | 65.5 | 66.8 | 65.7 |
| First dorsal ray | 3.0 | 3.0 | 3.2 | 3.1 | 3.4 | 3.6 | 2.9 | 3.1 | 2.5 | 2.7 |
| Second dorsal ray | 4.9 | 5.3 | 5.1 | 4.7 | 4.7 | 4.9 | 4.8 | 5.0 | 5.0 | Broken |
| Longest dorsal ray | 5.6 | 5.7 | 6.0 | 6.0 | 6.0 | 5.9 | 5.9 | 5.8 | 5.7 | 5.8 |
| Last dorsal ray | 2.8 | 3.4 | 3.7 | 3.0 | 3.3 | 3.2 | 3.3 | 3.3 | 2.7 | 3.5 |
| First anal ray | 2.6 | 3.1 | 2.7 | 2.6 | 3.2 | 1.5 | 2.1 | 3.2 | 1.7 | Aberrant |
| Second anal ray | 4.8 | 5.5 | 4.6 | 5.1 | 5.0 | 3.9 | 4.4 | 5.4 | 4.2 | Aberrant |
| Third anal ray | 6.5 | 6.9 | 6.9 | 6.4 | 6.6 | 6.5 | 6.5 | 6.6 | 6.5 | Aberrant |
| Longest anal ray | 6.9 | 7.3 | 7.3 | 6.6 | 6.7 | 7.3 | 6.8 | 7.2 | 6.7 | Aberrant |
| Last anal ray | 2.5 | 2.9 | 3.5 | 2.1 | 2.6 | 2.4 | 2.3 | 2.5 | 2.6 | 2.2 |
| Caudal fin length | 10.7 | 12.0 | 11.5 | 10.8 | 11.2 | 10.5 | 11.4 | 11.0 | Broken | 10.7 |
| Caudal concavity | 5.5 | 5.8 | 5.6 | 5.3 | 5.4 | 5.3 | 5.5 | 5.8 | — | 5.5 |
| Pectoral fin length | 9.2 | 8.8 | 9.0 | 9.0 | 8.4 | 8.8 | 8.7 | 8.5 | 8.9 | 9.2 |

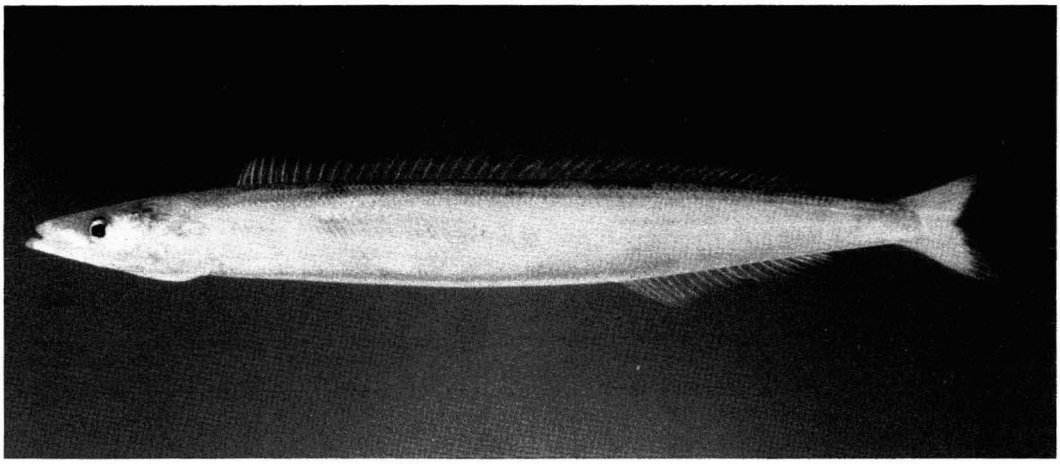

FIGURE 1. Holotype of *Ammodytoides pylei*, BPBM 33923, 142 mm SL, Kahe Point, Oahu (J. Randall).

except first six procurrent caudal rays; lateral-line scales 109 (109–116); scales above lateral line to origin of dorsal fin 2 1/2; scales below lateral line to origin of anal fin 15 1/2 (15 1/2–16 1/2); gill rakers 5 + 24 (5–7 + 23–25; one paratype with 6 + 27; total 29–33); branchiostegal rays 7; precaudal vertebrae 34; caudal vertebrae 25–26, usually 26; predorsal vertebrae 4; postdorsal vertebrae 10; neural and haemal spines of caudal vertebrae expanded; no supraneural (predorsal) bones; first two dorsal pterygiophores in space between fourth and fifth neural spines; a broad gap in suborbital series between first and remaining bones, this gap about one-twelfth of orbit rim.

Body moderately elongate, the depth 8.95 (8.55–10.0) in SL, without a longitudinal ventrolateral skin fold; body subcylindrical anteriorly, the width 1.35 (1.25–1.4) in depth, and somewhat compressed posteriorly, the width of caudal peduncle at point of least depth about half the depth; head pointed, its length 4.4 (4.25–4.55) in SL; snout length 3.25 (3.25–3.5) in head; adipose eyelid covering about one-third of iris; orbit diameter (maximum diameter to edges of adipose eyelid, which covers about one-third of iris) 7.3 (6.4–7.85) in head (eye diameter of holotype 6.2 in head); interorbital width 5.5 (5.4–6.65) in head; least depth of caudal peduncle 4.7 (4.55–5.1) in head; length of caudal peduncle 2.0 (1.9–2.3) in head.

Lower jaw strongly projecting, ending in a cartilaginous knob; maxilla attenuate posteriorly, reaching below or slightly posterior to front edge of eye, the upper jaw length 3.2 (3.05–3.35) in head; premaxilla greatly protrusible; mouth slightly oblique, forming an angle of about 15–20° to the horizontal; no teeth in jaws or on palate; labial ossicles present (see Ida [1973]); lips not fleshy; lower lip not extending to front of jaw (its anterior end below front of upper lip); tongue broad but moderately pointed. Gill rakers slender and long, the longest (at angle) about equal to greatest orbit diameter, four-fifths length of longest gill filaments; pseudobranchial filaments of holotype 22, the longest about half length of longest gill filament.

Nostrils in middle of upper side of snout, slightly above a line from upper edge of eye to front of upper lip; nostrils with a slight fleshy rim, the anterior about twice diameter of posterior; anterior and posterior nostrils broadly separated, the internarial space about half greatest orbit diameter. Nasal cavity large, subdivided by a thin longitudinal septum (instead of the usual olfactory lamella, there is a thin swelling of the olfactory epithelium just under the anterior nostril).

Gill opening broad, extending from above

level of upper edge of eye to below center of eye; gill membranes not attached to isthmus; opercle without spines; opercular flap long, narrowly rounded; free membranous posterior margin of preopercle extending slightly above level of upper edge of eye, the ventral margin nearly to a vertical at front edge of orbit.

Scales small, thin, cycloid, and unique in their arrangement in very straight diagonal rows (see Pietsch & Zabetian [1990]); head naked except for a row of small scales on upper part of opercle; scales dorsally on nape extending to above upper free end of preopercle (about 10–13 median predorsal scales); fins naked except caudal, which is scaled about three-fourths distance to posterior margin; lateral line high on body, ascending from upper end of gill opening to below origin of dorsal fin, thence passing posteriorly parallel to upper edge of body, the tubed scales ending about midlength of caudal peduncle; 5 to 8 pored scales in a row laterally at posterior end of caudal peduncle. Lateralis system of head (Figure 2*A*) discontinuous in suborbital region; occipital canal with three pores; pore at end of each suborbital single.

Origin of dorsal fin above eleventh lateral-line scale and seventh vertebra; first dorsal ray 7.55 (6.15–9.1) in head; second dorsal ray 4.6 (4.4–4.9) in head; remaining dorsal rays progressively longer to about the thirtieth, 4.05 (3.8–4.3) in head; last dorsal ray 8.1 (6.45–8.45) in head, the base ending above the fourteenth caudal vertebra; origin of anal fin below base of thirty-first or thirty-second dorsal ray and the second caudal vertebra; first anal ray 8.7 (6.9–14.8) in head; second anal ray 4.8 (4.05–5.7) in head; fourth anal ray longest, 3.3 (3.05–3.4) in head; last anal ray 9.0 (6.95–10.9) in head, the base ending below the sixteenth to eighteenth caudal vertebrae; caudal fin forked, its length 2.1 (2.0–2.1) in head, the caudal concavity 4.1 (3.8–4.35) in head; pectoral fins low on body, their upper base at level of lower edge of eye; fourth pectoral ray longest, 2.45 (2.45–2.8) in head.

Color of holotype in preservative: brown on back, the scale edges darker, shading to silvery on side and ventrally; head yellowish, becoming silvery on cheek, operculum, and snout above maxilla; a diffuse transverse dusky band across top of snout, partially enclosing nostrils; a small median dusky spot anteriorly on snout; front of lower jaw dusky; a small amount of blackish pigment dorsally on opercle, most evident adjacent to upper free end of posterior preopercular margin; dorsal, anal, and pectoral fins pale, the dorsal with a series of small, nearly square, blackish spots at margin (or slightly submarginal) on membranes 2, 8, 11, 17, 21, 25, 29, 33, and 35; then a very small smudge distally on most of the rays from 39 on; caudal fin with a broad dusky posterior margin and dusky longitudinal streaks on all but outermost rays.

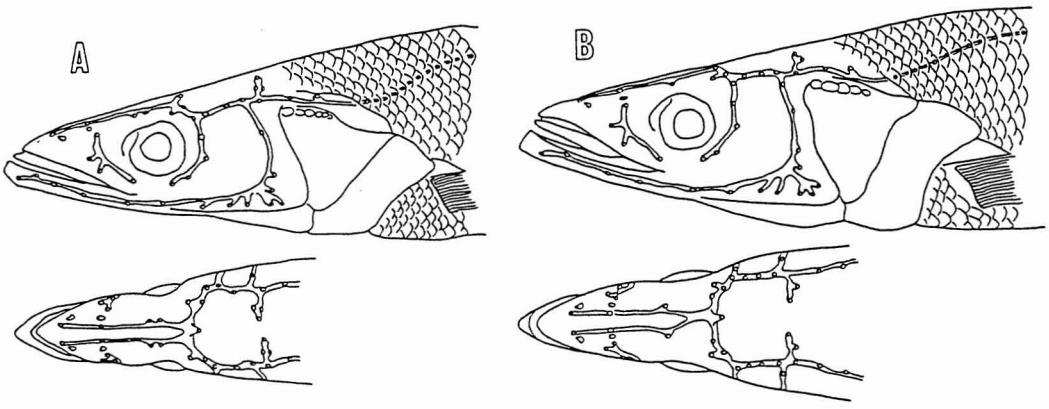


FIGURE 2. Dorsal and lateral views of the head of *Ammodytoides pylei* (*A*) and *A. vagus* (*B*) to show the cephalic sensory pores (H. Ida).

Color of holotype when fresh: body lavender-brown dorsally, shading through silvery lavender on side to silvery white ventrally; dorsal part of head and nape yellow with dusky markings as described for the preserved specimen; tip of lower jaw dusky yellow; membranes of dorsal, anal, and pectoral fins hyaline (except blackish spots distally on dorsal fin as described above), the rays lavender-white; caudal fin whitish with a dusky posterior border and faint blackish streaks paralleling rays.

Color of postlarvae in preservative pale with a prominent blackish blotch centroposteriorly in caudal fin.

HOLOTYPE: BPBM 33923, female, 142.0 mm, Hawaiian Islands, Oahu, Kahe Point, off power station, sand, 8 m, spear and hand nets, Richard L. Pyle, Arnold Y. Suzumoto & Jane B. Culp, 19 May 1989.

PARATYPES: BPBM 24868, 4: 130.0–141.0 mm, Hawaiian Islands, Molokai, Kaiwi Channel, 21° 8′ N, 157° 25′ W, 120 m, Clinton sled, *Townsend Cromwell* cruise 61, station 100, 1 November 1972; FSKU 73318, 3: 157.6–173.4 mm, Northwestern Hawaiian Islands, Ladd Seamount, 28° 34′ 3″ N, 176° 42′ 7″ W, 77 m, trawl, R.V. *Kaiyo Maru*, 18 March 1973; NSMT P 35113–14, 2: 156.8–167.5 mm, same data as preceding; BPBM 33498, 117 mm, Hawaiian Islands, Oahu, Kahe Point, off power station, sand, 7 m, net, John E. Randall, John L. Earle, Richard L. Pyle, Bruce A. Carlson, Therese Hayes & Jane B. Culp, 20 November 1988; BPBM 34915, 128.2 mm, LACM 45516-1, 131.8 mm, MNHN 1992-1, 123.1 mm, and USNM 316514, 137.0 mm, all with same data as holotype; BPBM 34913, 98.6 mm, Hawaiian Islands, Kauai, north shore off Princeville, sand channel in 8 m, fence net and dip nets, John L. Earle, John E. Randall, Nikolas Konstantinou & Kenneth and Linda Bail, 25 August 1991; NSMT P 35112, 93.2 mm, same data as preceding.

ADDITIONAL MATERIAL EXAMINED: BPBM 3416, 76 mm, Northwestern Hawaiian Islands, Pearl and Hermes Reef, T. Dranga, 17 May 1923; BPBM 24731, 48 mm, southwest of Oahu, 20° 45′ N, 158° 30′ W, surface, neuston net, *Townsend Cromwell* cruise 59, station 24, 20 July 1972; BPBM 24732, 50 mm SL, southwest of Kauai, 20° 54′ N, 159° 32′ W, surface, neuston net, *Townsend Cromwell* cruise 59, station 30, 21 July 1972; BPBM 24743, 2: 40–41 mm, southwest of Kauai, 20° 33′ N, 159° 39′ W, 50–100 m, Cobb trawl, *Townsend Cromwell* cruise 59, station 35, 22 July 1972; BPBM 24739, 2: 31–48 mm, about 100 miles south of Niihau, 20° 13′ N, 160° 10′ W, *Townsend Cromwell* cruise 59, station 44, 25 July 1972; BPBM 24741, 2: 25–33 mm, southwest of Kauai, 21° 10′ N, 159° 7′ W, 50–100 m, Cobb trawl, *Townsend Cromwell* cruise 59, station 46, 25 July 1972.

REMARKS: We are pleased to name this species in honor of Richard L. Pyle, the principal collector of the type specimens.

As mentioned above, we follow Ida, Sirimontaporn, and Monkolprasit (unpublished data) in classifying this species in the genus *Ammodytoides*. This genus was briefly described by Duncker and Mohr (1939), with *Bleekeria vaga* McCulloch & Waite from Lord Howe Island designated as the type species. Allen et al. (1976) and Eschmeyer (1990) accepted the genus as valid. Ida, Sirimontaporn, and Monkolprasit have described it more fully and distinguished it from *Bleekeria* by the following characters: no teeth in jaws; subocular canal interrupted below eye; caudal peduncle depth less than one-fourth head length (about one-third head length in *Bleekeria*); anal rays 21–25 (less than 18 in species of *Bleekeria*); neural and haemal spines of posterior caudal vertebrae expanded; suborbital bones 6 (8 in *Bleekeria*), and labial ossicles absent. Robert J. Lavenberg (pers. comm.) provided another character to separate the two genera. The lateral line of species of *Ammodytoides* ends high on the caudal peduncle, whereas that of species of *Bleekeria* curves downward and continues laterally onto the base of the caudal fin.

In addition to *A. vagus* and *A. pylei*, *Ammodytoides* includes *A. gilli* (Bean) (no type locality, but known thus far only from the eastern Pacific; *Ammodytes lucasanus* Beebe & Tee-Van, 1938, is a junior synonym; Robert J. Lavenberg, pers. comm.); *A. renniei* (Smith,

1957) from South Africa; *A. kimurai* Ida & Randall (1993) from the Ogasawara Islands; and a new species from Pitcairn Island to be described by Bruce B. Collette and J.E.R.

Of the species of the genus, *Ammodytoides pylei* seems most closely related to *A. vagus*, described from a single specimen from Lord Howe Island (AMS I.9274, 147 mm SL). A 65-mm specimen in poor condition from Shell Harbour, New South Wales, was identified as *Bleekeria vaga* by McCulloch (1926); it was deposited in the Australian Museum. This specimen appears to be lost, along with two other small New South Wales specimens (Mark McGrouther, pers. comm.).

No color in life was given for the holotype of *A. vagus*, and the color in formalin was noted only as uniform sandy yellow, the opercles blackish. Although evidently not noticed by McCulloch and Waite (1916), there is a row of small dark spots distally in the dorsal fin similar to that of *A. pylei*.

Counts and measurements were made of the holotype of *A. vagus* by J.E.R. Its counts of 48 dorsal rays, 22 anal rays, 17 pectoral rays, and 5 + 13 gill rakers are within the range of *A. pylei*; however, all are at the extreme of the range of each for *A. pylei*. The count of 107 lateral-line scales is lower than the counts of 109–116 for *A. pylei*. *A. vagus* has 58 vertebrae, whereas *A. pylei* has 59 or 60, usually the latter. Most body and fin measurements of the holotype of *A. vagus* lie within the range for *A. pylei*, but three differ: the orbit diameter of *A. vagus* is 3.2% SL (that of *A. pylei* of comparable size is 2.9–3.0% [see Table 1]); the interorbital width of *A. vagus* is 4.3% SL, compared with 3.5–4.1% for *A. pylei*; the pectoral-fin length of *A. vagus* is 10.0% SL, versus 8.4–9.2% for *A. pylei*. There is also a difference in the number of supraorbital and supratemporal pores (see Figure 2); *A. vagus* has three supraorbital pores in the intermediate position, compared with two for *A. pylei*, and two terminal pores of the supratemporal series, compared with three for *A. pylei*. Note also that the supratemporal canal extends farther medially on *A. pylei*.

*Ammodytoides pylei* also resembles *A. gilli*, sharing with it the series of small blackish spots distally in the dorsal fin. The latter differs in having fewer dorsal rays (46–47), fewer lateral-line scales (97–100), and fewer vertebrae (56–57) (meristic data of *A. gilli* provided by Robert J. Lavenberg).

Fowler and Ball (1925:27) identified a specimen of sand lance, 84 mm total length, from Pearl and Hermes Reef in the Northwestern Hawaiian Islands as *Bleekeria gilli*, and Fowler (1928:426, fig. 70) illustrated it by a drawing. This specimen, which appears to have been taken from the stomach of a predaceous fish, was deposited in the Bishop Museum under number 3416. The meristic data recorded by Fowler and Ball are well outside the ranges based on type material of *Ammodytoides pylei*. J.E.R. recounted the fin rays and scales of this specimen as follows: dorsal rays 51, anal rays 25, lateral-line scales 111, all of which are now consistent with the data of *A. pylei*. A gill-raker count of 6 + 24 was also made.

*Ammodytoides pylei* feeds on zooplankton in a loose aggregation as much as 5 m above the sand substratum. With the approach of danger, it forms well-coordinated schools near the bottom (Figure 3) and moves at remarkably high speed for such a small fish. When sorely pressed, it may dive into the sand. The projecting lower jaw tipped with a firm cartilaginous knob is an obvious adaptation for such a mode of escape. A strongly projecting lower jaw is also present in other slender sand-diving fishes such as trichonotids, creediids, kraemeriids, and microdesmids.

The highly protrusible premaxilla of the sand lances is an adaptation for fishes that feed individually on small animals of the zooplankton, but it is also found in certain benthic carnivorous fishes. Pietsch (1984) discussed the modifications of the jaw structure of ammodytids and other fishes with a protrusible premaxilla.

The first observation of living *Ammodytoides pylei* in the Hawaiian Islands, as mentioned above, was of their spawning by J.L.E. On 18 November 1989 (5 days before full

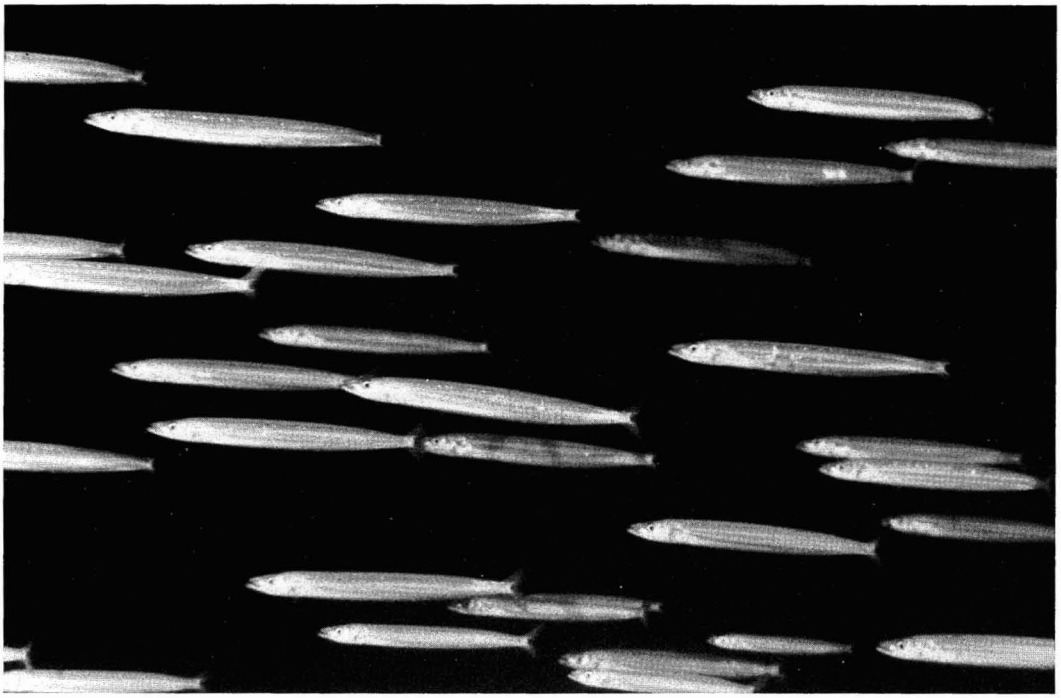

FIGURE 3. Part of a school of *Ammodytoides pylei*, off Kahe Point, Oahu, 8 m (J. Randall).

moon, on an outgoing tide), spawning was observed for about 1 hr commencing 1 1/2 hr before sunset. The spawning school, estimated at 80 individuals from still photographs, was seen at a depth of 8–9 m about 50 m southeast of the cooling water outlet for the electric power-generating plant at Kahe Point on the leeward coast of Oahu. The school was about 1.5 m long and 0.5 m high. The fish swam rapidly ca. 1 m above the sand substratum throughout a broad sandy area to which they were restricted. The spawning was carried out by tight clusters of from 8 to 30 individuals; these darted above the school diagonally in the direction of the school movement, releasing gametes at the apex of their spawning rise. The release of gametes was readily visible as a white cloud. The height of the spawning rise varied from 1 to 4 m above the school; it did not appear to be related to the number of fish rising. Gamete release was followed by immediate rapid return to the school. Throughout the spawning, the head of some, if not all of the fish appeared yellow. This color was not observed in plankton-feeding fish. On subsequent dates when divers drove the school closer than 1 m from the bottom, predation by synodontid fishes was observed.

On 21–23 May 1990, Pyle and Culp observed spawning at the Kahe Point site and videotaped the behavior. Full moon occurred on 8 May and on 9 June. From the tapes it was noted that spawning did not occur when the fish were swimming very rapidly (this rapid swimming was mainly evasive movement from divers who had ventured too near). Multiple spawnings within a short period (we counted as many as five within a period of 4 sec) often resulted in later groups going higher in the water column for the release of gametes than the first.

The school of *A. pylei* at Kahe Point was observed frequently in the same area between 18 November 1988 and 21 September 1990. This area is entirely of loose sand substratum,

approximately rectangular, one boundary about 200 m long defined by the warm-water plume from the Kahe power plant, which creates an offshore current. The other boundaries, one about 100 m to the south of the plume, are over sand and not related to any apparent landmarks on the bottom or to any obvious difference in the composition of the sand. Other fishes observed in the area include *Xyrichtys umbrilatus* (Jenkins), *Trachinocephalus myops* (Forster), unidentified *Synodus*, *Limnichthys donaldsoni* Schultz, and occasional *X. pavo* Valenciennes, *X. aneitensis* (Günther), and *Novaculops woodi* (Jenkins). A school of an undescribed *Leptojulis* was frequently observed just outside this area.

During the period of observation, there did not appear to be any recruitment to the school, which dwindled in size until only nine individuals were counted on 21 September 1990. A large swell scoured the area shortly thereafter; since then, no fish of this species have been observed at the site.

On 14 March 1991 a large aggregation of *Ammodytoides pylei* about 50 mm total length (hence possibly newly settled out) was discovered by J.L.E. at a depth of 16 m over sand substrate at Makua on the leeward coast of Oahu. This school, which mingled with small juveniles of the aforementioned *Leptojulis*, was observed to be preyed upon by carangids and synodontids. It disappeared from the area within a few weeks.

The uniform size of fish in the schools of *A. pylei* and the lack of recruitment to long-observed schools suggest that the postlarvae occur as aggregations in the pelagic realm and settle out together. The scarcity of sightings in seemingly suitable sand habitat, the lack of recruitment, and the apparent susceptibility to predation lead us to speculate that the center of population for *A. pylei* in the Hawaiian Islands occurs either at deeper than the usual scuba-diving depths or in the Northwestern Hawaiian Islands.

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