

***Pickfordiateuthis bayeri*, a new species of squid (Cephalopoda:
Loliginidae) from the western North Atlantic Ocean discovered
by submersible**

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Abstract.—We describe a previously unrecognized species of loliginid squid from the Bahama Islands, western North Atlantic. Two specimens of *Pickfordiateuthis bayeri* n.sp. were collected by submersible from a large aggregation in mid-water (110–113 m over a depth of 1000 m) offshore of Abaco Island. Both specimens were fully mature, mated, un-spawned females. We suggest that the occurrence of *P. bayeri* in this habitat, unusual for all known species of the genus, represents an offshore mating migration.

Fifteen species of cephalopods were observed in situ from the research submersible *Johnson-Sea-Link II* (J-S-L II) during an autumn cruise aboard the Harbor Branch Oceanographic Institute's R/V *Seward Johnson*. The cruise investigated the deep waters about 2 km off shore of Abaco Island, Bahama Islands on 2–12 October 1988 (MV participated in the cruise). Many small squids were observed on dives 1677 and 1678 and videotaped on 1678. Two of the scores of small "loliginid-like" specimens that were observed and videotaped were captured during J-S-L II Dive 1678, in the Northwest Providence Channel about 2 km off Rocky Point, Abaco Island.

The specimens were first observed in an unconsolidated aggregation near the surface following the launch of the *J-S-L II* after dark. The large swarm of several dozen small squids was attracted to the lights of the submersible and followed it during its descent from the surface to 274 m (900 feet). Some specimens were videotaped at 85 m depth (temperature 25.2°C), and the submersible descent was stopped while two specimens were captured alive at 110–113 m (23.8°–23.9°C). While the aggregation of

squid remained with the submersible during descent in mid-water to 274 m, no recognizable, consolidated schooling behavior was observed. The squid ceased to follow the submersible below 274 m (circa 8°C). The captured specimens remained alive during the dive, then were placed in a ship-board aquarium where they were photographed. Subsequent examination of the specimens revealed them to be mature female *Pickfordiateuthis*, but they did not conform to any of the known species of this unusual genus.

We describe here the two submersible-caught specimens as a new species. We are pleased to name this new species in honor of Professor Frederick M. Bayer, our long-time colleague and friend. This designation seems especially fitting because this name joins the patronym, *P. vossi*. Drs. F. M. Bayer and G. L. Voss were life-long friends and colleagues who shared countless field trips together, from paddling on south Florida grass flats and coral reefs to major deep-sea expeditions by RSMAS (Rosenstiel School of Marine and Atmospheric Science, University of Miami, Florida) to seas as far afield as the Gulf of Guinea, Africa.

As professors and mentors to one of the authors (CFER), these two pioneers had a profound influence on his academic development and career.

Measurements and indices in the following description and tables conform to those defined in Roper and Voss (1983). To facilitate comparison, the order of the characters presented in the description closely mirrors the format used by Brakoniecki (1996) in his revision of *Pickfordiateuthis*. We concur with Brakoniecki's placement of *Pickfordiateuthis* in the Loliginidae. See Brakoniecki (1996) for the familial taxonomic description as well as synonymies and references to other *Pickfordiateuthis* species.

Family Loliginidae (Lesueur, 1821)

Genus *Pickfordiateuthis* Voss, 1953

Pickfordiateuthis Voss, 1953:602; Voss, 1956:107; Toll, 1982:49; Brakoniecki, 1986:117; Hess, 1987:178; Haimovici et al., 1989:504; Brakoniecki, 1996:9.

Diagnosis.—Mantle short to moderately elongate, bluntly pointed to broadly rounded posteriorly; fins not connected posteriorly (sepiolid-like), large and elliptical to round, to very small and round; buccal membrane lacks suckers; tentacular club with 2 rows of suckers on at least some of the proximal region. Photophores absent. (Modified from Brakoniecki 1996:10)

Pickfordiateuthis bayeri, new species

Figs. 1–3

Material examined.—Holotype: Female, 26 mm mantle length (ML), Bahama Islands, 25°59.79'N, 77°27.88'W, Northwest Providence Channel off Rocky Point, Abaco Island, *J-S-L II* dive 1678, 6 Oct 1988, 2130 hours launch, capture depth 110–113 m, temperature 23.8°C, bottom depth 1000 m, USNM 817134. Fixation in 10% buffered formalin; preservation in 50% isopropyl alcohol.

Paratype: Female, 23 mm ML, (all collection data as above), USNM 893737.

Description.—Mantle long, moderately narrow, cylindrical; abruptly tapered posteriorly to a very bluntly rounded posterior end (Fig. 1, preserved specimen); mantle width $\frac{1}{2}$ ML (MWI 34–35). (Lateral sides of fixed specimens are concave, an artifact of preservation, while they are convex in photographs of live specimens, a result of swimming action). See Table 1 for measurements and indices. Anterior mantle margin with distinct, terminally rounded, dorsal lobe about 1.3% of ML. Ventral margin deeply indented in broad arc ventral to funnel, with distinctly pointed lobes of the locking apparatus at ventrolateral mantle margin.

Fins very small, length about $\frac{1}{5}$ ML (FLI 20.3–23.0), rounded, nearly circular, subterminal, not fused posteriorly; FWI 45–47.8. Fin margins very thin, almost membranous. Posterior lobes free, extending only slightly beyond posterior tip of mantle, and inserted near tip of mantle; separation between lobes equals 3% of ML. Anterior fin insertions on dorsal mantle widely spaced; separation equals 20% of ML.

Head small, short, narrower than mantle width; head width less than $\frac{1}{3}$ ML (HWI 28).

Funnel relatively large, robust, extending anteriorly nearly to level of mid-eye. Funnel length index 31.9–34.7; funnel width index 20. Funnel locking component straight, simple, very long, nearly 20% of ML and 60% of funnel length; groove narrow, distinct, deep. Mantle locking component long, straight, with sharp ridge.

Funnel organ dorsal component deeply U-shaped around outer margin; lateral arms long, narrow; medial margins straight, meeting anteriorly in sharp V; low median ridge formed into small, pointed, anterior, apical papilla (Fig. 2D). Paired ventral pads, large, oblong; posterior tips rounded and anterior ends narrowed into angular, pointed tips.

Buccal membrane simple, no lappets (outer margin nearly smooth); seven buccal supports very weakly developed. Short

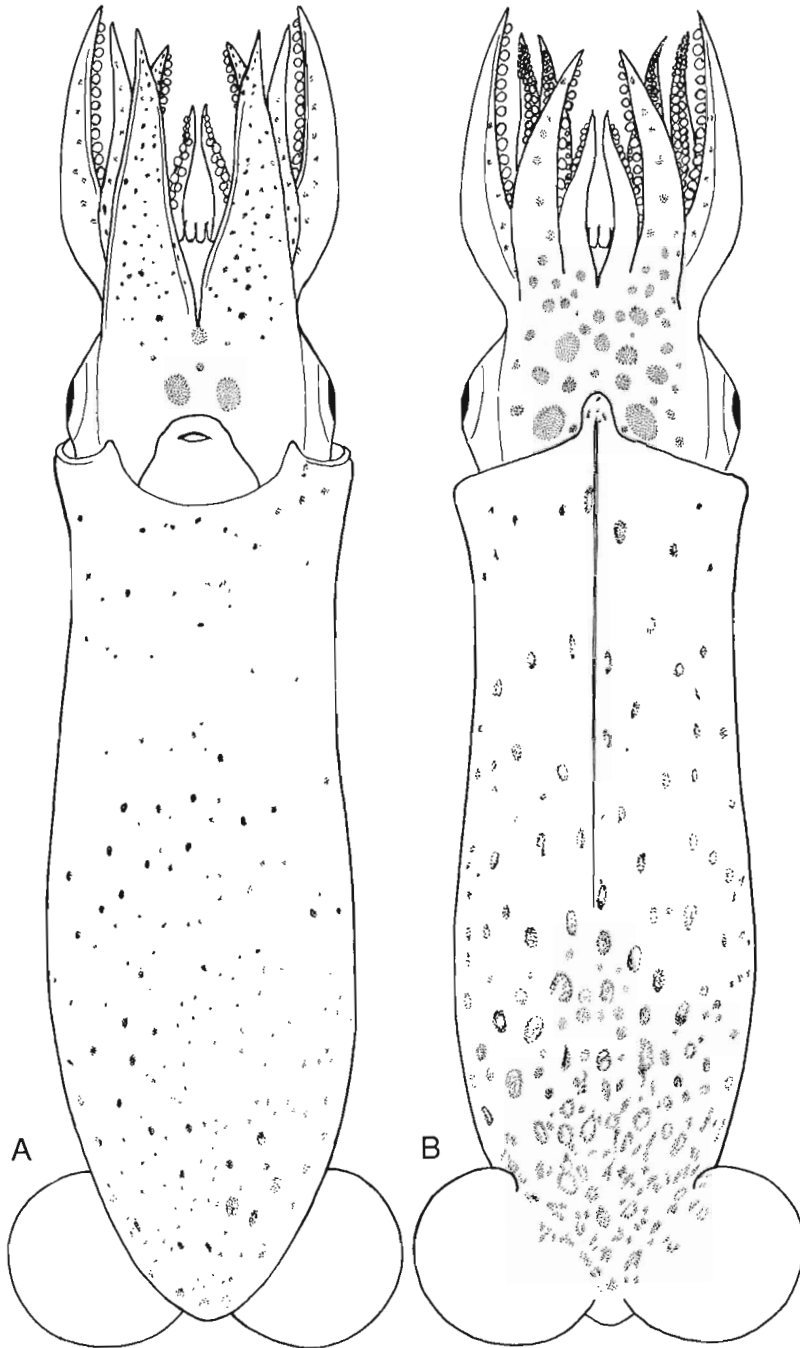


Fig. 1. *Pickfordiateuthis bayeri*, new species; holotype, mantle length 26 mm; A. ventral and B. dorsal views. Scale, 5 mm.

Table 1.—Measurements (mm) and indices (% of ML) of *Pickfordiateuthis bayeri*. Club length index is given as % of ML/% of TL. (—) indicates data unavailable; + indicates value is a minimum. (Characters defined in Roper & Voss 1983, Brakonieccki 1996).

Character	Holotype		Paratype	
	26		23	
ML				
MW/MWI	8.6	33.0	7.3	31.7
HW/HWI	7.3	28.3	6.1	26.5
FL/FLI	5.3	20.3	5.3	23.0
FW/FWI	11.7	45.0	11.0	47.8
ALI/ALI-I	4.8	18.4	4.3	18.6
ALII/ALII-I	7.5	28.8	5.8	25.2
ALIII/ALIII-I	7.8	30.0	6.5	28.2
ALIV/ALIV-I	6.6	25.3	6.6	28.6
TL/TLI	8.3	31.9	7.5	32.6
CL/CLI	3.3	12.6/39	2.7	11.7/36
Fin insert W, Posterior	0.83	3.1	0.5	2.1
Fin insert W, Anterior	5.0	19.2	3.6	15.6
MW @ Ant. Insert.	6.3	24.2	5.6	24.3
MW @ Widest	9.1	35.0	7.8	33.9
M dorsal lappet length	1.3	5.0	1.1	4.7
GL/GLI	25.3	97.3	—	—
GW/GWI	5.5	21.3	—	—
Eye diameter	4.1	15.7	4.0	17.3
Funnel length	8.3	31.9	8.0	34.7
Funnel width	5.3	20.3	4.8	20.8
Funnel tube length	6.0	23.0	5.8	25.2
Funnel opening diameter	1.3	5.0	0.9	3.9
Funnel lock length	5.1	1.9	—	—
Funnel lock width	1.5	5.0	—	—
Gill length	9.0	34.6	8.0	34.7
Gill width	0.16	0.6	0.15	0.6
Gill lamellae number	32	—	24+	—
Nidamental Gland length	8.0	30.7	6.6	28.6
Nidamental Gland width	5.8	22.3	4.3+	18.6+
Egg length	1.6	6.1	1.1	4.7
Egg width	0.83	3.1	0.83	3.6

spermatangia with conical, filamentous-tipped bodies implanted around entire inner surface of buccal membrane.

Both specimens are fully mature, mated females with implanted spermatangia. Posterior two thirds of mantle cavity completely occupied by large swollen nidamental glands (30% of ML) and fully packed ovary with eggs in oviduct. Eggs very large, 1.1–1.6 mm long (ELI about 6) by 0.83 mm wide, fewer than 50 in number. Gills very long, narrow, over 1/3 ML (gill length index 34.6.)

Males unknown.

Arms short, robust; III and IV with especially broad, aboral keel. Arm tips broad-

ly attenuate. Order: III >/ = IV >/ = II > I. Protective membranes low, scalloped. Suckers in two rows on all arms; those on II and III much larger than suckers on I and IV; fewer than 20 suckers on each arm. Outer sucker rings on largest suckers broad, granular; inner sucker rings smooth proximally with a few (about 6) small, blunt teeth distally.

Tentacles very short, TLI about 32, only slightly longer than longest arms (ca. 110%); very slender, not robust. Aboral keel along stalk proximal to club very low, not extending full length; low extensions of protective membranes on club extend proximally on oral surface of tentacular stalk.

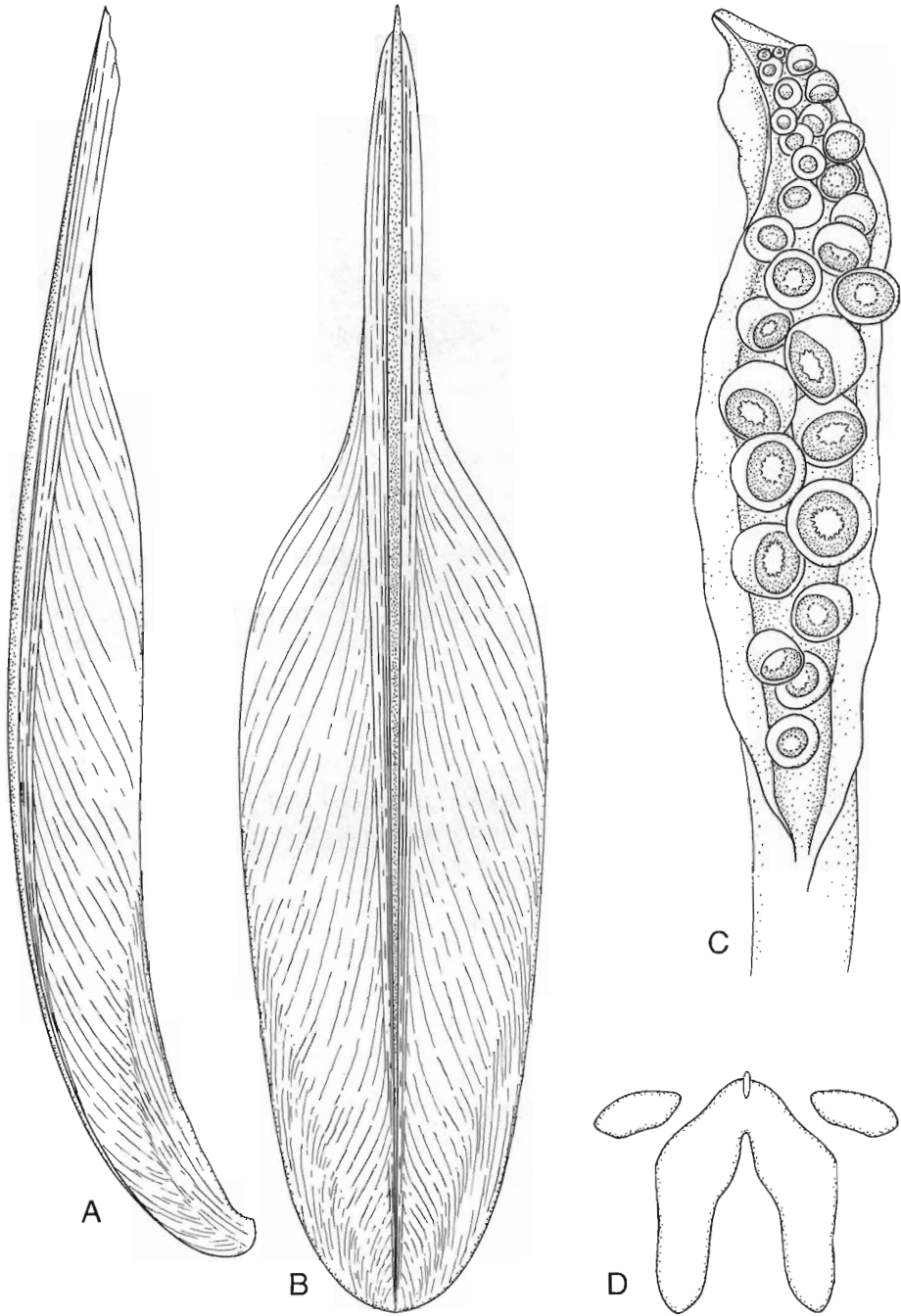


Fig. 2. A-D. *Pickfordiateuthis bayeri*, new species. A. Gladius, lateral view. B. Gladius, ventral view. C. Left tentacular club. D. Funnel organ. All from holotype, mantle length 26 mm.

Club short, CLI 12 (37% of tentacle length); expansion varies between specimens and rapidly attenuates to tip; no distinct carpus (Fig. 2C). Suckers in two rows proximally: two small proximal-most suckers; 4–5 pairs enlarged manal suckers; 3–4 rows of rapidly smaller suckers in about 4–5 transverse rows distally on dactylus. Large manal suckers with distinct teeth. Width of dorsal and ventral protective membranes equal to height of erect manal suckers. Aboral keel on club only an angular ridge proximally, grading to a very low membrane distally, then smooth at the tip.

Gladius with long (GLI 97.3), narrow, straight-edged free rachis, bluntly pointed at anterior tip. Gladius of holotype wide (GWI 21.3), not flattened. Vanes deep, spoon-shaped, and very broad posteriorly (Fig. 2A, B). Large, broad head and funnel retractor muscles attached to mantle near anterior section of vane where gladius broadens from rachis to full vane width.

Color in preserved specimens.—Dorsal mantle surface with scattered, faded, brownish chromatophores; chromatophores especially thickly distributed on posterior end of mantle, some quite large. Ventral mantle without expanded chromatophores, but small dot-like chromatophores occur over the ventral surface. Chromatophores more numerous and larger posteriorly between fins; chromatophores indistinct on fins. Dorsal surface of head with numerous multi-sized, dark chromatophores, mostly in pairs to right and left of mid-line. Ventral surface of head with very few, faded chromatophores, deeply imbedded in tissue. Ventral funnel with one huge chromatophore on each side of midline at level of mantle opening. Arms and tentacles lined with two to several longitudinal rows of small, reddish-brown chromatophores that extend to tips.

Color in live specimens.—(from color transparencies of squid maintained alive aboard ship; Fig. 3A). Dorsal mantle entirely covered with densely packed chromatophores. Oval, red chromatophores

most prominent in number and size, less densely spaced anteriorly; chromatophores so closely packed posteriorly that their edges converge, giving a uniform red coloration. Smaller yellow chromatophores interspersed among the red chromatophores anteriorly, giving way posteriorly to brown and dark brown chromatophores among the large red chromatophores; brown chromatophores, especially, exhibit different stages of expansion. Dorsal head covered with densely packed, large, dark red and dark brown chromatophores. Arms covered with closely packed, small, light red chromatophores with underlying yellow ground coloration, especially on arms II. Tentacles not visible in photographs. Fins translucent, lack distinct coloration, except for a few minute chromatophores around the edges. (Possibly the fine skin on the fins was damaged while the specimens were in the capture chamber for the duration of the dive). Live animals and transparencies give a strong impression of juvenile loliginids, both in chromatophore type (color, size, distribution) and overall pattern and coloration.

Additional live specimen color notes.—Photograph (Fig. 3B) taken at night in deep Bahamian waters from *J-S-L* submersible in October 1979 (Youngbluth, pers. comm.) shows a small squid that appears to be *P. bayeri* in ventrolateral view in mid-water with completely black background. (Note: because the original images of the squids in Fig. 3B, C were so small and underexposed, they had to be significantly enlarged; therefore the colors might not be precisely represented in the final images). Red and yellow chromatophores evenly distributed over mantle, head and arms, similar to that in the type specimens. However, degree of expansion differs from preserved specimens; yellow chromatophores are larger and red chromatophores are reduced. No chromatophores sufficiently expanded to merge with neighboring chromatophores; consequently, mantle and mantle cavity transparent where no chromatophores occur. Yellow ground

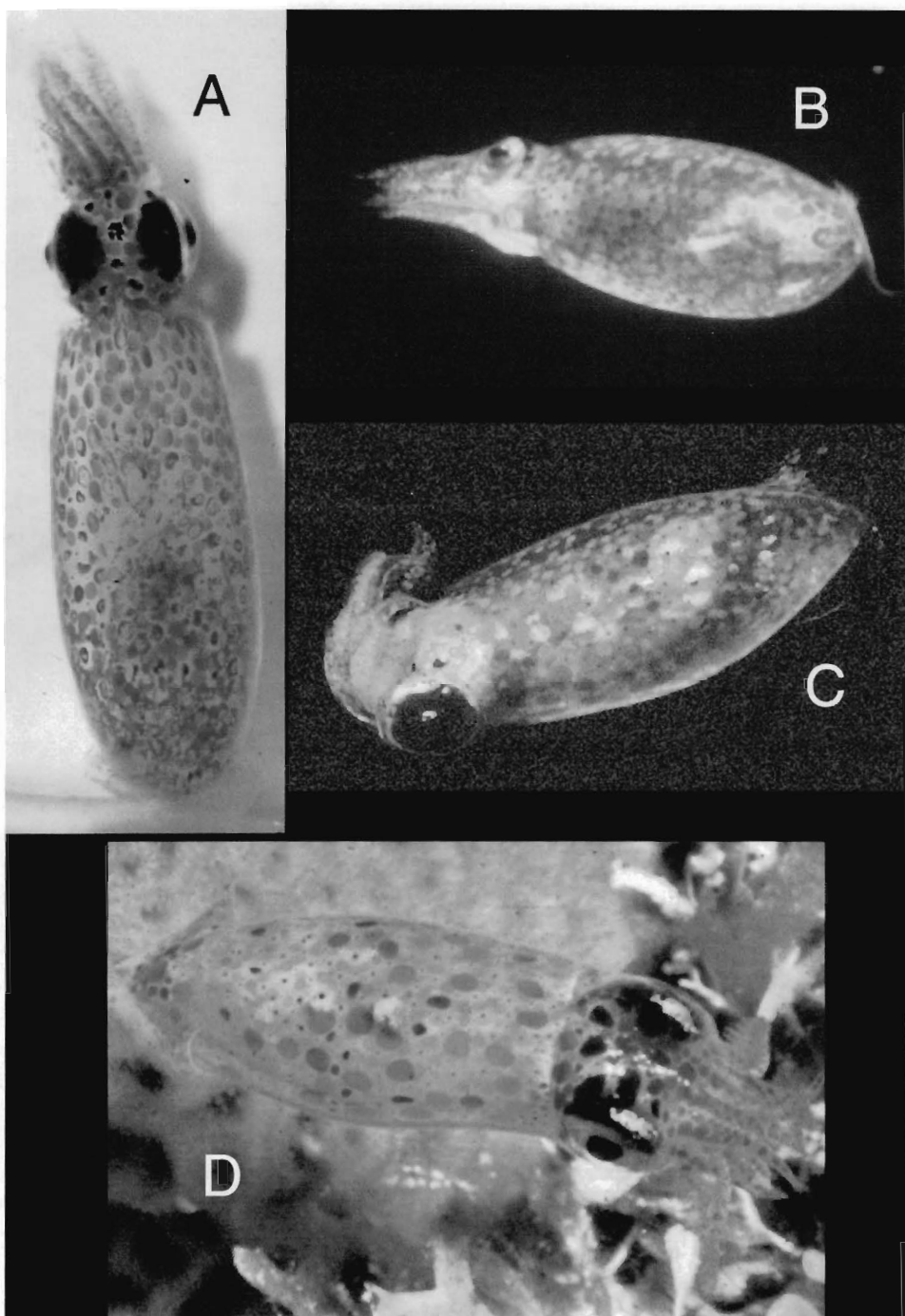


Fig. 3. Photographs of live *Pickfordiateuthis*. A., *P. bayeri* new species; B, C and D, probably *P. bayeri*, but specimens not captured, so identification cannot be confirmed. A. Captive specimen, holotype, 26 mm mantle length; off Abaco Island, Bahamas (M. Vecchione photograph). B. Image from video tape of specimen filmed at night from submersible over deep water; Bahama Islands (M. Youngbluth photograph). C. Photograph of specimen at night swimming in shallow water above fringing reef; Anthony's Key, Roatan Island, Honduras (R. Hanlon photograph). D. Same specimen and locality as C, photographed on shallow fringing reef at night (R. Hanlon photograph; previously published in Norman (2000:147) as *P. pulchella*).

coloration occurs on all arms. Arms short and tentacles are not visible. Fins translucent, pigment indistinct. Two photographs of a squid that appears to be *P. bayeri* were taken in Roatan, Honduras with SCUBA at night (R. Hanlon, pers. comm.). In Fig. 3C with black background the squid has small chromatophores around the outer edges of the fins and on the anterior medial bases where the fins insert with the mantle. Figure 3D shows the squid hovering over the (artificially) well-lighted, complex, fringing reef habitat with a heavy concentration of chromatophores on the posterior dorsal mantle, as described in the two captured specimens. Arms 3 are splayed laterally, showing the broad, aboral keels. This photograph appeared in Norman (2000:147) identified as *P. pulchella*. We note that the squid pictured in Fig. 3D appears to have a shorter, broader mantle and possibly a different chromatophore configuration than the *P. bayeri* depicted in Fig. 3A. These differences might reflect the different circumstances under which the photographs were taken and the condition of each individual.

Distribution.—Currently known only from the type locality in the Bahama Islands, subtropical western North Atlantic.

Holotype.—Fully mature, mated female, 26 mm ML; USNM 817134.

Paratype.—Fully mature, mated female 23 mm ML; USNM 893737.

Type locality.—Bahama Islands, 25°59,79'N, 77°27.88'W, Northwest Providence Channel off Rocky Point Abaco Island, captured at 110–113 m in mid-water by submersible over bottom depth of 1000 m. The holotype and paratype were “slurped” by a pump-activated, suction collecting chamber from a swarm of several dozen conspecific specimens.

Etymology.—As noted above, this fascinating new species of loliginid squid is named with gratitude in honor of Dr. Frederick M. Bayer, who has contributed so significantly to the fields of systematics, nomenclature and invertebrate zoology. Dr. Bayer has shared his immense knowledge

with innumerable students, young scientists and colleagues during his long, productive and distinguished career.

Discussion.—The type of the genus, *P. pulchella* Voss, 1953, was described from the northern Florida Keys from shallow-water sea grass beds. Subsequently it has been reported to occur from south Florida (Miami) through the Caribbean islands to Panama by Brakoniecki (1996) and to Brazil by Haimovici et al. (1989).

A second species, *P. vossi* Brakoniecki, 1996, was described from shallow waters of the Pacific and Gulf coasts of Baja California, Mexico. Brackoniecki (1996) described another species, *Pickfordiateuthis* species A, from the southern Caribbean (Gulf of Honduras to Guyana) that differs markedly from *P. pulchella*; all 11 specimens were captured by trawl at depths that ranged from 12.8–78.6 m, and most were mature females, though unmated.

Comparison of species.—We examined material of *P. pulchella* (holotype and non-type specimens) and the holotype and paratypes of *P. vossi*. *Pickfordiateuthis bayeri* n. sp. is distinguished from the other known species in the genus (*pulchella* Voss, *vossi* Brakoniecki, and species A Brakoniecki) by the combination of its elongate mantle; broadly rounded posterior end of mantle; very small, round, terminal fins with widely spaced posterior attachment to mantle; very short, thin tentacles; very large suckers on the manus of the tentacular club; arm suckers few in number and enlarged. Chromatophores occur on the visceral-pericardial membrane of *P. pulchella* and *P. sp. A*, but they are not noticeable on *P. vossi* or *P. bayeri*. However, because the specimens have been in isopropyl alcohol since 1988, any existing chromatophores could have been bleached beyond recognition. The overall shape of *P. bayeri* is similar to the Pacific species, *P. vossi*, but the tentacular clubs are quite different.

Table 2 presents a comparison of mean indices for females of the four species of *Pickfordiateuthis*. Males are known only

Table 2.—Comparison of mean indices in females of the four known species of *Pickfordiateuthis*. Data for previously described species from Brakonjecki (1996).

	<i>P. bayeri</i> , n.sp.	<i>P.</i> <i>pulchella</i>	<i>P. vossi</i>	<i>P. species A</i>
<i>n</i>	2	11	11	7
ML	24.5	15.2	15.1	9.4
MWI	32.5	44.3	43.0	63.5
HWI	27.5	42.9	37.1	65.9
FLI	21.5	46.2	30.0	55.2
FWI	46.5	78.8	58.2	109.6
ALI-I	18.5	33.5	21.6	40.9
II	27.0	48.8	30.9	58.6
III	29.6	58.5	35.6	75.2
IV	27.0	50.2	29.5	64.2
TLI	32.2	94.2	36.7	144.6
CLI	37.5	30.1	33.1	34.0

from *P. pulchella* and *P. vossi*. Female *P. bayeri* attain a greater mantle length at maturity, up to 26 mm ML, than the other species. The mantle width and head width of *P. bayeri* are significantly narrower than in *P. pulchella*, *P. vossi* and *P. sp. A*. The fins are very short and narrow in *P. bayeri*, much smaller than in the other three species, and they are subterminal, not lateral, as in *P. pulchella* especially. Arms and tentacles are shortest in *P. bayeri*, slightly longer in *P. vossi*, very much longer in *P. pulchella*, and especially so in *P. sp. A*. The clubs of *P. bayeri* are slightly longer relative to tentacle length than in the other species. The gills of *P. bayeri* are long and robust, while those of *P. vossi* are short and broad, and of *P. pulchella* intermediate.

Finally, *P. bayeri* from the Bahamas, western Atlantic Ocean, appears more similar to *P. vossi* from the Pacific and Gulf coasts of Baja California than to *P. pulchella* from the tropical and sub-tropical western Atlantic and Caribbean. Even so, all three named species are quite distinct. Species A also appears to be distinct, but we have no specimens for comparison.

Habitat.—The open-water habitat over deep bottom depths where the two specimens of *P. bayeri* were captured and scores of others were observed in a swarm or ag-

gregation, is quite different from that of the other species of *Pickfordiateuthis*. The water depth beneath the swarm was 1000 m, beyond the drop-off just offshore from the southern tip of Abaco Island, Bahamas. A photograph, which appears to be our new species, was published by Norman (2000: 147) with the identification noted as *P. pulchella*. (This photograph is the same as our Fig. 3D, but the negative was reversed in publication and the stated locality is incorrect). Based on its subterminal fins and short arms, we suspect that it might be *P. bayeri*. If so, the photo, taken in Roatan Island, Honduras in a shallow, highly structured fringing reef, with a steep drop-off into very deep water (R. Hanlon, pers. comm.) indicates another habitat for the species. *Pickfordiateuthis pulchella* occurs in shallow water sea grass beds of only a few meters depth. *Pickfordiateuthis vossi* was collected in near-shore shallow waters (20–25 m), while *P. species A* was caught in 10-foot benthic otter trawls at 12–80 m depths in near-shore shallow water.

Since all specimens observed from the submersible in the swarm of *P. bayeri* were about the same size as the two mature, mated, captured specimens, we assume all specimens were mature. We suggest that the concentration of specimens could represent a mating aggregation (not school) that forms when these small, cryptic, benthic squid leave their shallow habitat and move into nearby open water, increasing opportunities for mating and decreasing exposure to shallow water predators. This suggestion is strengthened by the photograph we have of another Bahamian specimen, probably of *P. bayeri*, but not collected; it was photographed from a J-S-L submersible in mid-water at night in October, 1979 in deep waters. No species of *Pickfordiateuthis* is known to school or aggregate for mating and spawning in shallow water, as is the case with several other genera of loliginid squids. Extrapolating size dimorphism and consolidated, even same sex, schooling be-

havior to *Pickfordiateuthis* is unwarranted, given the uniqueness of these little squids.

While we are unaware of other shallow-water cephalopods with this type of mating behavior, we recognize that several other groups of marine invertebrates have similar behaviors. For example, species of the galatheid crustaceans, *Munida* and *Munidopsis* (Decapoda: Anomura), vacate shallow benthic habitats to spawn in the open sea. Polychaetes, such as the palolo worm, emerge from the sediment, swim up into the water column to spawn at night; the embryos disperse, then settle the next day (K. Fauchald, pers. comm.). These examples are not the same behavior as we observed with *P. bayeri*, but they indicate a reproductive strategy that is represented in several major groups of marine invertebrates. Confirmation of this hypothesis for *P. bayeri* awaits additional observations and collections of adults in their pre-mating, pre-spawning habitats. Furthermore, spawning locale, egg mass configuration and paralarval habitats need to be discovered. The discovery of a new species of cephalopod in waters so frequently visited and collected is fascinating to us. Perhaps *Pickfordiateuthis bayeri* is a very cryptic species that becomes exposed, en masse, only during its mating season.

Acknowledgments

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