

***Paraliparis hawaiiensis*, a new species of snailfish (Scorpaeniformes: Liparidae) and the first described from the Hawaiian Archipelago**

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Paraliparis hawaiiensis n.sp. is described from the north-western Hawaiian Islands from two specimens collected at 2196 and 3055 m. It differs from other North Pacific Ocean species in its chin pore arrangement, tooth pattern and body proportions. Although liparid specimens have previously been collected from Hawaii, they were undescribed and are now lost. Therefore, this is the first liparid species described from the archipelago. *In situ* photographs of Hawaiian snailfishes are also shown and discussed here.

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Key words: abyssal; French Frigate; Laysan.

INTRODUCTION

Although liparids (snailfishes) have been collected from widely distant deep water locations in the eastern North and Central Pacific Ocean (Chernova *et al.*, 2004), the Galapagos Islands (Stein & Chernova, 2002), and the coasts of Peru and Chile (Stein, 2005), no liparids have been described previously from the Hawaiian Archipelago. Snailfishes have apparently been collected previously from the area (Mundy, 2005) but were subsequently lost. Other individuals have been photographed, but because voucher specimens did not exist, the species could not be identified or described. This paper describes a new species of *Paraliparis* Collett 1879 from two specimens collected from the north-western archipelago near French Frigate Shoals and Laysan Island at depths of 2196 and 3055 m (Fig. 1), and presents and discusses photographic records of Hawaiian liparids.

MATERIALS AND METHODS

For definitions of characters, measurements and counts, this study follows the methods and terminology described by Stein *et al.* (2001), Andriashev (2003) and Stein (2012).

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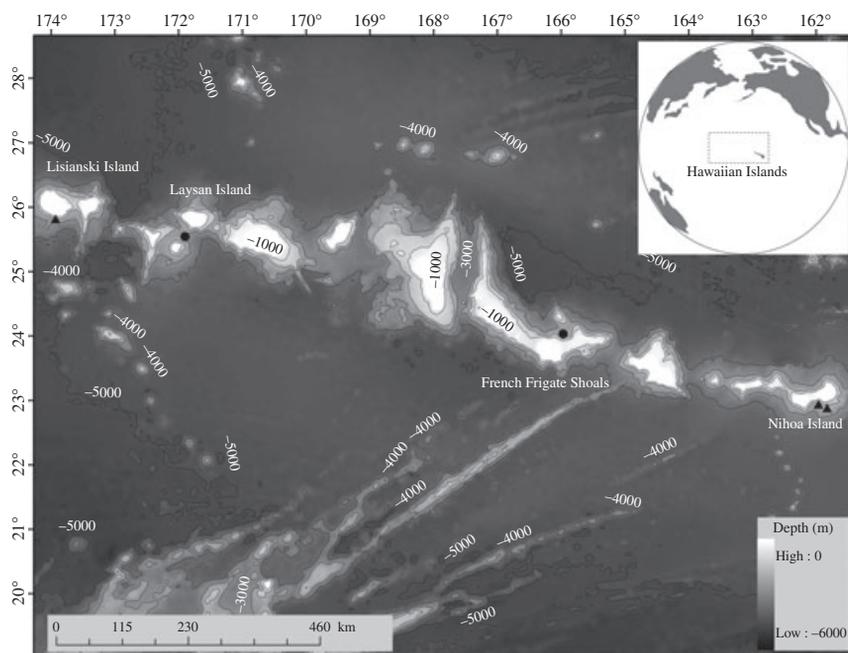


FIG. 1. Distribution of *Paraliparis hawaiiensis* n.sp.: collections (●) and positions of *in situ* photographs (▲).

Specimens were radiographed to obtain counts of medial skeletal elements and the right pectoral girdle of the paratype was dissected, cleared, and stained by the method of Taylor (1967a, b) to show its skeletal elements. Whole specimens were temporarily stained with cyanine blue (Saruwatari *et al.*, 1997) to show the pores and other fine detail. Sex was determined and stage of maturity established visually. Museum abbreviations follow Sabaj Pérez (2013). Ratios for the holotype are given as per cent standard length (L_S) or head length (L_H) followed (in parentheses) by the sparse data for the paratype, which unfortunately was in extremely poor condition allowing most counts but only the measurement of L_S . The specimens are deposited in the California Academy of Sciences fish collection.

In situ photographs were taken using a downward focussed baited camera system (Yeh & Drazen, 2009). The camera takes four megapixel digital images of *c.* 2 m² of the seafloor at 2 min intervals over a 24 h period. From March 2006 to July 2008, baited camera deployments were made at various depths from 250 to 4700 m throughout the Hawaiian Island chain. The liparid specimens were collected using a large trap (1 m × 1 m × 0.5 m; 1.3 cm plastic mesh) that was baited with skipjack tuna *Katsuwonus pelamis* (L. 1758) (as was the camera) and deployed for *c.* 24 h before recovery. The trap had plastic mesh funnels with outer dimensions of 18 cm × 61 cm. Abbreviations for measurements, counts and proportions used in the description are given in Table I.

RESULTS

PARALIPARIS HAWAIIENSIS NEW SPECIES (Figs 1–3)

HOLOTYPE (Figs 2 and 3)

CAS 234828, female, 149 mm L_T , 132 mm L_S , 24° 1.801' N; 165° 57.944' W, near French Frigate Shoals, R.V. *Hiialikai*, Stn FFS-B, 13 June 2009, 2196 m.

TABLE I. Abbreviations for meristic measurements, counts and proportions

Characteristics	
Measurements	
L_S	Standard length
L_T	Total length
L_H	Head length
Counts	
V	Vertebrae
D	Dorsal-fin rays
A	Anal-fin rays
C	Caudal-fin rays
P	Pectoral-fin rays
R1–R4	Pectoral-fin girdle radials, numbered from dorsal to ventral
pc	Pyloric caeca
Body measurements expressed as part of ratios (in proportion to L_S or L_H)	
aAf	Distance from anus to anal-fin origin
bd	Body depth
E	Eye horizontal diameter
go	Gill opening length
HW	Head width
io	Interorbital width
lj	Lower jaw length
LLD	Lower lobe distance: from the base of the lowest ray of one lower pectoral-fin lobe to that of the other fin
LPL	Lower pectoral-fin lobe length
ma	Tip of lower jaw to anus
mabd	Tip of lower jaw to posterior end of abdominal cavity
orbit	Horizontal orbit width
pabd	Posterior edge of pectoral symphysis to end of abdominal cavity
preA	Preanal-fin length
preD	Predorsal-fin length
sn	Snout length; anteriormost point of head excluding lower jaw to anterior margin of orbit
sna	Snout to anus distance
uj	Upper jaw length
UPL	Upper pectoral-fin lobe length

PARATYPE [Fig. 2a)]

CAS 234829, sex unknown, >151 mm L_T , c. 141 mm L_S , 25° 32.526' N; 171° 54.004' W, near Laysan Is., R.V. *Hiialikai*, Stn LAY_A, 29 June 2009, 3055 m (pectoral girdle removed, cleared and stained).

DIAGNOSIS

Vertebrae 68–69, pectoral-fin rays 20–21, rudimentary rays absent, caudal-fin rays seven. Radials 2+0+1. Chin pores almost touching, in a deep transversely oval

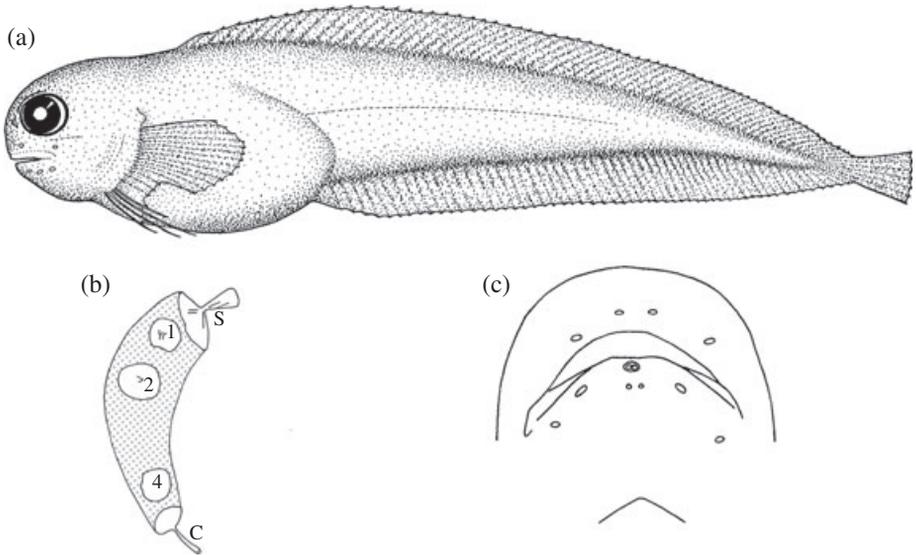


FIG. 2. (a) *Paraliparis hawaiiensis* n.sp. Holotype, CAS 234828, female, 149 mm total length, L_T , 132 mm standard length, L_S . Right side reversed. (b) Paratype, CAS 234829, lateral view of right pectoral girdle. 1, 2, 4, radials; S, scapula; C, coracoid; stippled area, cartilage. (c) Holotype, ventral view of lower jaw and snout pores.

pigmented pit appearing to be a pore, with a pair of rudimentary pores symmetrically located immediately posterior to the pit. Head short, $c. 16\% L_S$. Upper jaw about half L_H . Teeth simple canines forming moderately wide bands. Snout about a quarter L_H .

DESCRIPTION

Counts: V 69 (68), D 62, A 55, C 7, P 20, 20 (21, $c. 20$), pectoral radials 3, pc 6 (6). Ratios. In $\% L_S$: L_H 16.3%, HW 12.4, sn 4.2, E 4.8, orbit 5.6, io 8.6, uj 8.3, lj 6.4, UPL 13.6, LPL 12.6, LLD 4.6, bd $c. 21.4$, preD 26.0, preA 39.0, sna 19.2, ma 15.6, aAf 25.8, pabd 28.5, mabd 36.5. In $\% L_H$: HW 76.3, sn 25.6, E 29.3, orbit 34.4, io 53.0, uj 51.2, lj 39.5, UPL 83.7, LPL 77.7, LLD 28.4, bd $c. 131.6$, preD 159.5, preA 239.5, sna 117.7, ma 95.8, aAf 158.1, pabd 174.9, mabd 224.2.

Head short, low, more than one sixth L_S and shallower than body; dorsal profile evenly rounded from blunt, almost vertical, deep snout to occiput. Nostrils single, short tubular, on horizontal through centre of eye. Mouth horizontal, subterminal, oral cleft short, its posterior end below anterior of pupil; upper jaw reaching to behind mid-eye. Teeth simple, stout, blunt canines, innermost (largest) with hints of shoulders. Pre-maxillary teeth in about 23 oblique curved rows of up to $c. 10$ teeth each, forming moderately wide bands; lower jaw teeth similar. Both jaws possibly with narrow symphyseal tooth gaps. Eye large in relation to head, prominent, dorsal margin of orbit not entering dorsal profile of head and well below it. Gill opening probably completely above pectoral base; opercular flaps damaged in both specimens, but opercle present, consisting of a double horizontal spine. Posterior pores damaged; remaining pores moderately large, lacking raised or thickened rims. Chin pore pair touching, at the

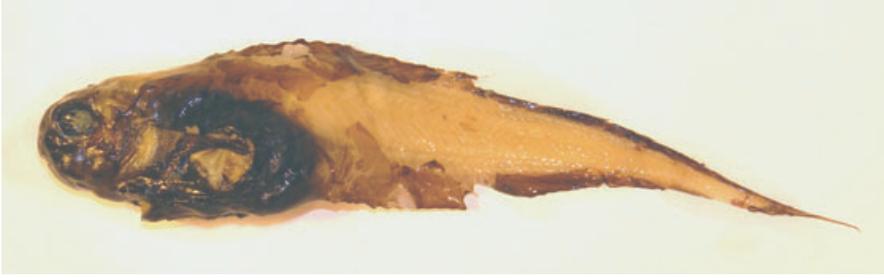


FIG. 3. Photograph of *Paraliparis hawaiiensis* n.sp. Holotype, CAS 234828, female, 149 mm total length, L_T , 132 mm standard length L_S . Right side reversed.

bottom of a prominent deep pit appearing to be a single pore; a symmetrically arranged pair of rudimentary pores just posterior to it [Fig. 2(b)].

Pectoral fin divided into lobes by moderately deep notch. Dorsal-most ray about on or above a horizontal through middle of orbit. Upper lobe $>80\% L_H$, lower lobe slightly shorter. Upper lobe not nearly reaching end of abdominal cavity or anal-fin origin, lower lobe reaching to below middle of upper lobe, anterior to mid-abdomen. Pectoral rays $14 + 3 + 3/4$, rudimentary rays absent, rays of notch much more widely spaced than in upper or lower lobes. Base of anterior-most lower-lobe ray well behind orbit, about below tip of suborbital stay. Lower lobes of pectoral fins relatively distant from each other, c. $30\% L_H$. Right pectoral girdle of paratype [Fig. 2(a)] with three ($2 + 0 + 1$) rounded but not round, unnotched radials; foramina absent. R2 largest, R1 and R4 almost equal in diameter. Scapular blade deep, its lower limb much longer than upper; helve very well developed, with a broadly rounded tip. Coracoid extremely and unusually long and slender, its blade broadly rounded.

Body depth increasing gradually from occiput to above end of abdominal cavity, then tapering evenly to caudal fin. Deepest point of body apparently behind mid-abdomen, which is swollen with large eggs in holotype. Trunk distinctly deeper than head, even after removal of egg masses. Abdomen deep; peritoneum and body cavity extending dorsally to a horizontal through dorsal edge of orbit or possibly above it. Vertebrae $10 + 59$ (paratype unknown). Predorsal length about a quarter L_S , dorsal-fin origin between fifth and sixth vertebrae, anal-fin origin between 11th and 12th vertebrae. Preanal-fin length about two fifths L_S . Deepest parts of dorsal and anal fins at about half fin length, much deeper than anterior portions. Anus positioned relatively far posteriorly, located below or slightly behind a vertical through posterior edge of pectoral girdle. Pyloric caeca six, thick, digitate, located left ventrally on stomach. Hypural fused, no slit evident, caudal fin with seven ($3/4$) rays. Skin translucent, thin, fragile; subepidermal cellular matrix (Eastman *et al.*, 1994) thick, transparent and gelatinous, especially on anterior of abdomen and at occiput.

In alcohol, skin remnants on body translucent brown, black peritoneum showing through body wall (Fig. 3); head dark brown, pectoral fins blackish brown. Orobranchial cavity dusky. Peritoneum black, stomach and pyloric caeca pale.

The holotype has apparently ripe eggs up to 4.2 mm in diameter.

DISTRIBUTION

Known from two specimens collected from the north-western Hawaiian Archipelago, which is now the Papahānaumokuākea Marine National Monument at 2196–3055 m (Fig. 1). The two specimens were not collected close to each other; rather, the holotype was caught near French Frigate Shoals, and the paratype near Laysan Island.

ETYMOLOGY

The name *hawaiiensis*, from the Hawaiian Islands, referring to the locality of collection of this species.

COMPARISONS

Known species of *Paraliparis* number *c.* 136, of which at least 37 occur in the Northern Hemisphere. Of these, chin pore arrangement is apparently unknown for 25 because many descriptions do not describe the chin pores. Based on all information available for this study, all *Paraliparis* previously known to have a single chin pore or chin pores in a pit are from the Southern Hemisphere.

The unusually deep chin pore pit of *P. hawaiiensis* distinguishes it from most other liparids. Mundy (2005) listed *Paraliparis meridionalis* Kido, 1985 as a Hawaiian species based on four liparid specimens collected off Oahu in shrimp traps at depths of *c.* 600 m, from surveys described by Ralston & Tagami (1992). The specimens were tentatively identified as *P. meridionalis* by R. Moffitt (NOAA). The specimens are lost (B. Mundy, pers. comm.), however, and their identification is questionable, considering the great distance from the location of the types (610–932 m, Okinawa Trough, Japan; Kido, 1985). Doubts about identification aside, *P. meridionalis* has chin pores not in a pit (*v.* pores in a deep pit), eight caudal-fin rays (*v.* seven), pectoral-fin rays 22–23 (*v.* 20–21), upper jaw 46.2–48.2% L_H (*v.* >50), shorter snout–anus distance of 85–97% L_H (*v.* 118), and other differences from *P. hawaiiensis*.

At first examination, the deep chin pore pit appears to be a single pore, potentially leading to confusion with species of *Paraliparis* known to have a single chin pore. These include *Paraliparis ekaporus* Stein, 2012 (Ross Sea), *Paraliparis haploporus* Stein, 2012 (Ross Sea), *Paraliparis impariporus* Stein, Chernova & Andriashev 2001 (Tasmania) and *Paraliparis monoporus* Andriashev & Neyelov 1979 (South Shetland Islands). The new species differs clearly from all of these in the arrangement and pigmentation of the chin pores (*v.* a true single pore) and in having a shorter head (16.3 *v.* 17.6–20.8% L_S), shorter snout (4.2 *v.* 4.6–7.2% L_S) and a longer upper jaw (51.2 *v.* 43.2–47.0% L_H) in addition to other differences from individual species.

Other species having a chin pore pit (including those described from Australia by Stein *et al.*, 2001: *Paraliparis australiensis*, *Paraliparis csiroi*, *Paraliparis dewitti*, *Paraliparis gomoni*, *Paraliparis infeliciter* and *Paraliparis obtusirostris*) have a more or less shallow depression that cannot be mistaken for a pore. With the exception of *P. obtusirostris*, which has closely spaced chin pores, all these species also have the chin pore pair widely separated.

If the pit and chin pores are missing or damaged, *P. hawaiiensis* would most easily be confused with species having teeth uniserial or absent (Stein, 2012, 113) (especially small individuals), having similar number of vertebrae, dorsal, anal and pectoral-fin rays, and general proportions. It differs clearly from all those species in its dentition

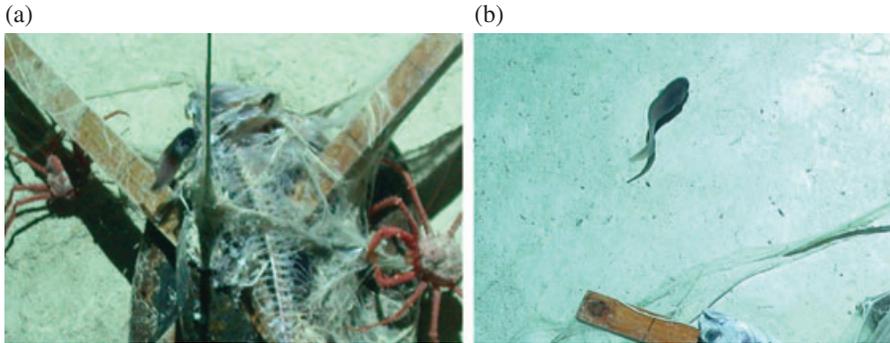


FIG. 4. Unidentified liparids photographed *in situ* at camera bait. Divisions on the wooden scale bars are 10 cm. (a) Nihoa Island, 8 July 2007, 22° 56.310' N; 161° 57.660' W, 2348 m. (b) Lisianski Island, 14 July 2007, 25° 49.085' N; 173° 55.824' W, 2224 m.

(teeth in bands *v.* uniserial or absent), and various proportions, depending on the species to which it is compared. The pectoral girdle of *P. hawaiiensis* may also be unusual in the long, slender scapula and coracoid.

COMMENTS

The depth of the chin pore pit in *P. hawaiiensis* is unusual and possibly unique in the family. A true single pore has unpigmented walls, does not have a close pair of pores at the bottom, and has a distinctly thickened rim. In contrast, *P. hawaiiensis* has the pit walls pigmented, a distinct pore pair at the bottom and no thickened rim. The similarity of this pore pit and pores to a single pore suggests this could be an intermediate stage in the development of a true single pore.

Although the paratype is in poor condition, the characters that can be determined (pectoral-fin ray counts, tooth shape and arrangement, head structure, stomach and pyloric caeca), are identical to those of the holotype. Consequently, there is no hesitation in considering it as conspecific.

DISCUSSION

In addition to the specimens described above, liparids have been noted in three deployments of baited camera systems off Hawaii at depths of 2000–2348 m. Photographs from two of those deployments are shown (Fig. 4). In all the photographs the fishes were swimming around and over the skeleton of the bait towards the end of the camera deployment (after >12 h) and most of the scavenging fishes were gone. In a third photograph, since lost, a liparid was seen at Nihoa Island in 2008 (14 July 2008, 22° 52.993' N; 161° 49.565' W, 2000 m). It is not possible to positively identify the fishes from these photographs but they look like *Paraliparis*. At the time the photographs were initially examined, the liparids were noted as unidentified fishes, probably small cusk eels (Ophidiidae). After capturing the two specimens in the trap, the photographs were reanalysed and some of the unidentified fishes could be

identified as liparids. Eight deployments of the camera system at 1000, 1500 and 3000 m did not record liparids (Yeh & Drazen, 2009).

Collection of the specimens was made possible by R. Kosaki (Papahānaumokuākea Marine National Monument) and financial support from the Papahānaumokuākea Marine National Monument (NOAA). Work in the Papahānaumokuākea Marine National Monument was conducted under Permit #PMNM-2007-027 to J.C.D.; J. Yeh (U. of Hawaii) and C. Choy (U. of Hawaii) assisted with field collections. C. Madsen drew the holotype (Fig. 2), other drawings (Figs. 2a, 2b) by D. Stein. D. Simonds (OSU) made the radiographs.

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