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NOTE

LIVE CAPTURE OF LARVAL BILLFISHES: DESIGN AND FIELD TESTING OF THE CONTINUOUS ACCESS NEUSTON OBSERVATION NET (CANON)

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Basic research on larval billfish biology and ecology has been hampered by difficulties with species identification, the capture of live specimens, and their survival after capture (Richards, 1974; Post et al., 1997; Serafy et al., 2003). Whereas, genetic techniques are helping to resolve the identification problems (McDowell and Graves, 2002; Hyde et al., 2005; Luthy et al., 2005), obtaining live, uninjured billfish larvae for scientific study remains a serious obstacle (Idrisi et al., 2003; Serafy et al., 2003). To date, the most successful effort to collect live istiophorid larvae, and to subsequently maintain them in captivity, was conducted by Post et al. (1997). They sampled over a 2-yr period off Miami, Florida with a circular, 1 m diameter plankton net with 1 mm mesh. By limiting their neuston tow duration to 2 min or less, overall larval istiophorid survival immediately after collection was 30%.

Building on the Post et al. (1997) work, we addressed the problem of live billfish collection by developing a new neuston gear in which tow duration can span, uninterrupted, whatever time period desired, and while underway, its cod-end contents are both viewable and immediately collectable. The rationale behind the “continuous access neuston observation net” (CANON) design is that the key to minimizing larval injury (due to net abrasion, turbulence, and interactions with other organisms in the cod-end) lies in reducing the time larvae spend in the collection gear. Here, we describe the components, configuration, and operation of the CANON as well as provide results of its performance relative to conventional neuston net sampling. Possible future applications for this new gear are also described.

Methods

Materials and Design.—The CANON was constructed with the following materials: (1) a 1 mm mesh neuston net (6 m long), fabricated by Sea Gear, Inc. (Florida); (2) 3 m length of 2.5 cm-diameter stainless steel rod, for the (1 m × 0.5 m) net frame; (3) a 30 cm length of 10.1 cm-depth, aluminum I-beam stock for the net frame bracket; (4) 2 m of white, 15.2 cm-diameter polyvinyl chloride (PVC) pipe and “T” connector, for the PVC collection chamber and viewing tube; (5) 34 cm of clear, 13.6 cm-diameter polyacrylic tubing, for the removable collection canister; (6) a 50 cm length of 7.6 cm square stainless steel stanchion tubing; and (7) stainless steel wire bridle cable and shackles.

A schematic of the CANON components and its configuration between the hulls of a 7.9 m-long catamaran is shown in Fig. 1. Designed to sample just below the waterline, the mouth of the neuston net was lashed to the net frame utilizing parachute chord. The rectangular net frame was attached to a pre-installed mounting bracket under the vessel’s bow by means of a stanchion. The stanchion tubing contained a series of holes allowing for net frame height adjustment and for swiveling out of the water during transit. The net frame was stabilized by means of two bridle cables, which connected the lower corners of the frame to “U” bolts located on the underbelly of the bow decking.

The distal end of the net narrowed to become a tubular canvas sleeve designed to fit snugly over a 24 cm length of 15.2 cm-diameter PVC pipe. This terminal pipe was received (without

Bulletin of Marine Science

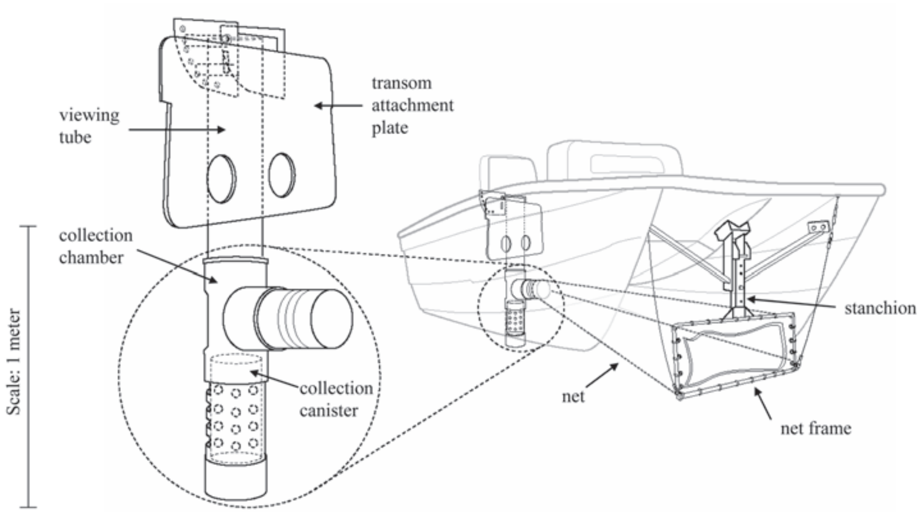

Figure 1. Schematic of the CANON (continuous access neuston observation net) in its sampling position (see text for details). Note that the collection canister and its contents are accessible by pulling on monofilament lines (not shown) that extend upwards to the top of the viewing tube.

glue) by the horizontally-oriented fitting of PVC T-connector; the remaining T fittings were oriented vertically. A 60 cm length of 15.2 cm-diameter PVC pipe was glued into the upper vertical T fitting, which allowed the operator on the rear deck to look downwards at captured items. This viewing tube was secured via an adjustable aluminum bracket that was welded to a rectangular plate (100 × 75 cm, 6.4 mm-thick). Into the lower vertical T fitting was glued a 36 cm section of 15.2-cm PVC pipe that was capped at the bottom. This lower section was slotted along its trailing face to allow water to flow though the system; it housed the collection canister, which could be pulled upwards (via monofilament lines) by the operators whenever desired.

Operation.—To facilitate travel to and from sampling locations, the bow-mounted stanchion and net frame assembly was swiveled upright out of the water with the net gathered on the forward deck of the vessel. Likewise, the entire transom-mounted PVC collection chamber was swiveled upright out of the water. Once on site, the stanchion-net frame assembly and the PVC collection chamber were each swiveled into their vertical sampling positions, where they were secured with bolts. Next, the body of the net was lowered over the bow, and guided aft between the hulls to the stern-mounted PVC collection chamber. After ensuring its appropriate orientation, the net was stretched taut by pushing the terminal pipe at its distal end into the horizontal T fitting of the PVC collection chamber. A bungee cord held the terminal pipe in the T fitting. The elastic cord served to dampen net movement stresses on the transom-mounted collection chamber during sampling and also allowed for quick disconnect if the net and/or collection chamber became clogged with flotsam. Neuston sampling ensued upon placement of the collection canister into the bottom of the PVC collection chamber, with the vessel moving forward at a speed of approximately 3 kts. A flow meter (Model 2030, General Oceanics, Inc., Miami, Florida) was attached across the frame for quantification of water volumes filtered. Geolocation, temperature, and salinity were continuously recorded utilizing the vessel's Garmin Model 2010c geographical positioning system and SeaBird Model 21 thermosalinograph.

Performance.—We examined the performance of the CANON via comparison of its catch versus a standard, commercially-available neuston net (Sea-Gear model 9400 series with a cylindrical (9 cm × 38 cm PVC) cod end. The performance of the CANON and conventional net was compared with paired t-tests in terms of: (1) larval istiophorid catch per volume filtered (i.e., numbers, regardless of larval disposition); (2) percentage of larval istiophorids alive immediately after sampling; and (3) live larval istiophorid catch per volume filtered. The conventional net had the same mouth dimensions and mesh size. Simultaneous sampling of the CANON and the conventional neuston net was achieved by towing the latter off the port side of the vessel while maintaining a gentle 5° port turn to minimize vessel wake-related influences. The tow duration during sampling was 10 min., at a speed of about 3 kts and the volume filtered by the conventional net was calculated from readings obtained from a second flowmeter mounted in the lower corner of its mouth. The conventional neuston net was towed with approximately 20% of its area above the water surface, which is standard practice with this gear (Leis et al., 1987; Post et al., 1997; Serafy et al., 2003). Therefore, its volume filtered values were calculated as 0.8 × mouth area × distance towed. This correction increases conventional neuston net catch per unit volume estimates by 20%.

Immediately upon completion of the simultaneous tows, the contents of the CANON canister and conventional net cod-end were gently transferred into white plastic sorting trays. All larval istiophorids captured were then counted and the disposition of each, i.e., whether they were dead or alive, was determined visually based on their swimming behavior in response to a tactile stimulus. Once relevant data were recorded at sea, specimens were stored in 70% ethanol. In the laboratory, larvae were identified to species following Luthy et al. (2005) and measured for standard length (SL).

Results

During August 2005, 11 pairs of neuston collections were made via simultaneous sampling with the CANON and the conventional neuston net in pelagic waters off Miami, Florida. This effort yielded a total of 104 istiophorid larvae, ranging from 3.5 to 12 mm SL, with 78 (75%) captured using the CANON. All larvae but one were identified as sailfish, *Istiophorus platypterus* (Shaw in Shaw and Nodder, 1782); the exception was a blue marlin, *Makaira nigricans* Lacépède, 1802 (SL = 5.2 mm SL). The CANON resulted in significantly higher mean values for all three of the performance measures examined (Table 1). On average, the CANON produced a 2.5-fold higher larval istiophorid catch, a 2.4-fold higher proportion alive value, and a 4.9-fold higher live larval istiophorid catch per volume filtered. All three between-gear performance differences were statistically significant ($P < 0.04$).

Discussion

The results above suggest that the CANON system has superior properties to conventional neuston nets of similar dimensions, especially for collection of live larval specimens. Our mean percentage (45%) of live istiophorid larvae after 10 min of CANON sampling exceeds the 30% obtained by Post et al. (1997), who made 2-min duration neuston tows with a conventional net. In practice, however, even higher live catches can be obtained using the CANON: (1) if specimens are removed as soon as they are observed, rather than after the 10-min time period that we established to

Table 1. Comparison of larval istiophorid catches using a conventional neuston net vs the continuous access neuston observation net (CANON). The conventional net and the CANON were deployed simultaneously from the same vessel in pelagic waters off Miami, Florida (see text for details). Between-gear differences in means were all significant (i.e., $P < 0.04$).

Gear performance Mesurement	Conventional net				CANON			
	N	Range	Mean	SE	N	Range	Mean	SE
Catch per 100 m^3	11	0.00–1.46	0.58	0.14	11	0.21–4.88	1.46	0.41
Proportion alive	11	0.00–1.00	0.19	0.11	11	0.00–1.00	0.45	0.09
Live catch per 100 m^3	11	0.00–0.75	0.14	0.08	11	0.00–2.33	0.67	0.19

equitably compare the two gear types; and (2) considering that more time in a given sampling day (or night) can be devoted to uninterrupted collection per se because net deployment and retrieval is all but eliminated.

As was evident in the conventional neuston collections of Leis et al. (1987) in the vicinity of the Coral Sea, variance in our larval billfish catches increased with the mean; however, this was not true for our proportion alive values. The CANON was designed specifically for capture of live larval billfish because traditional live capture techniques employed for other species or life stages have thus far been ineffective and/or unreliable. The practice of "night-lighting" (i.e., using dip nets around light sources deployed at night just below the water surface) can be effective for collecting live juvenile billfish ranging 39–130 mm total length (Idrisi et al., 2003), but not billfish larvae of the size range collected in this study (i.e., < 12 mm). Similarly, light traps which often catch uninjured scrombrid larvae, do not appear to be a reliable method for collecting live larval billfishes (pers. comm.: J. Leis, Australian Museum; M. Meekan, Australian Institute of Marine Science; R. Shaw, Louisiana State University).

Precisely why the CANON yielded higher larval billfish catches per unit volume than the conventional neuston net is uncertain. One possibility is that the vessel's two hulls, which flank the CANON net frame and extend about 1 m before it, serve to direct larvae into the gear. Also, the absence of a conventional wire bridle may enhance capture by eliminating vibration and disturbance ahead of the CANON. Another possibility for higher CANON catches may relate to CANON sampling being centered on the −55 to −5 cm depth stratum vs −40 cm to 10 cm depth stratum of the conventional net. Further study is needed, however, to determine if catch differences are driven by the vessel hulls, larval position in the water column, and/or differential larval response to approaching gear. The higher proportion of live billfish is likely due to the relatively large size of the specialized CANON cod-end, which presumably results in lower injury-causing turbulent forces acting on larvae during sampling.

The CANON design allows operators to sample quantitatively at whatever temporal resolution they desire including adaptively (e.g., according to when the target organism is first observed in the PVC collection chamber), or for neuston "scoping" purposes (i.e., patch detection). For the latter, CANON operators might work in tandem with other research vessels equipped with much larger conventional gear and/or instrumentation that would otherwise be sampling the neuston "blindly". Another application for the CANON is to address concerns that feeding in the net during capture may lead to a distorted view of larval fish diet, and thus trophic linkages. Because capture time and organism concentration are reduced using the CANON relative to conventional net sampling, studies following Hirota (1984) and Baier and Purcell (1997) deserve consideration, whereby items in the guts of organisms collected in conventional nets (towed for varying durations) are compared with those collected with the CANON.

In summary, the CANON design, or some modification of it, holds promise as a means of increasing live larval billfish capture rates by reducing the stresses associated with the collection process. Of course, this is just an initial step toward the ultimate goal of obtaining and holding meaningful numbers of live young billfishes for physiological and behavioral studies (de Sylva et al., 2000, Idrisi et al., 2003). Currently under design are two larger CANON systems: one for use on the University of Miami's R/V F. G. Walton Smith, a 30 m research catamaran; and the second system for a 16 m mono-hull sportfishing vessel. We anticipate research on live, larval billfishes and other neustonic organisms will advance as larger vessels are equipped with CANON, or CANON-like systems and laboratory facilities are equipped with adequate aquaculture systems to promote survival after capture.

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