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Effect of light-sticks and electralume attractors on surface-longline catches of swordfish (*Xiphias gladius*, Linnaeus, 1959) in the southwest equatorial Atlantic

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Abstract

Two experimental fishing trials were carried out off the coast of Pernambuco, Brazil, in 1999 and 2001, using a small artisanal longliner. In experiment 1, six-hook baskets with three chemical light-sticks on alternating hooks had significantly higher catch rates than those with zero or with a light-stick on every hook, with most swordfish accounted for by hooks with light-sticks. Analysis of the data from experiment 2 showed no significant difference between electralume attractors, consisting of AA lithium batteries protected by a solid cover and light-sticks that produce a fluorescent light when two chemical products are mixed. Significant differences were detected in mean CPUE by size class, with most swordfish belonging to class 'b' (125–170 cm lower jaw to fork length (LJFL)). No differences, however, were found for swordfish catches in classes 'a' (<125 cm LJFL) and 'b', and no evidence was found of interaction between the two factors (attractor and size class). Although there was no significant difference between the total length-frequency distributions of swordfish caught with light-sticks and electralume attractors, significant differences were found for fish smaller than 125 cm LJFL, with electralume catches consisting of smaller swordfish than those of gear using light-sticks.

Keywords: Swordfish; *Xiphias gladius*; Longline; Light-stick; Electralume; Brazil

1. Introduction

Since the introduction of surface-longline gear in the Atlantic Ocean in the mid-1950s, significant catches of swordfish (*Xiphias gladius*) have been reported. In the beginning of the 1960s, other fleets rapidly converted to longline, stimulated by reports of incidental catches by Japanese and USSR longliners targeting tuna or sharks, respectively (Beckett, 1974). In the late 1970s, swordfish started to gain economic importance, due to its high commercial value in the external markets.

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In the mid-1990s, American longliners leased by a company located in Natal-RN (Rio Grande do Norte), Brazil, began to target swordfish in the Southwestern Equatorial Atlantic (Hazin et al., 2000). These vessels were equipped with recent advances in pelagic longline design, including monofilament mainlines and chemical light-sticks, that are designed to increase fish attraction to the baits. Stimulated by the success of the fishery, the company adopted this new technology in two artisanal vessels, constructed of wood and powered by small four-cylinder engines in August 1997 (Hazin et al., 2000). Preliminary analysis indicated that artisanal longliners could achieve viable catches (Hazin et al., 2000). However, there was a lack of knowledge about the effects of the different gear configurations on performance and selectivity.

The effectiveness of longlines is influenced by numerous inter-related environmental and technical factors (Løkkeborg and Bjordal, 1992). The most important technical factor is the stimuli associated with bait and light (Løkkeborg, 1990, 1991; Løkkeborg and Johannessen, 1992; Løkkeborg and Bjordal, 1995; Johannessen et al., 1993).

Recently, the electralume, a new type of luminous attractor, was developed. Unlike the cyalume sticks that are not reusable, electralumes work with batteries last for several fishing trips. Being a new product, its efficiency and yield are still not very well known.

Because luminous attractors represent a significant component of overall costs (∼36%) (Hazin et al., 2000), particularly for small-scale operations, knowledge about the relative effectiveness of different types and their deployment along the longline is required to maximise return per hook set. The goals of the present study were to analyse the influence of the number of chemical light-sticks per basket as well as their efficiency in terms of catch rates of swordfish in comparison with electralume attractors.

2. Materials and methods

The experimental fishing trials were carried out off the coast of Pernambuco, Brazil (approximately 6 nm) at depths of 1000–2000 m. The hooks were set at depths from 30 to 150 m. Each gear was composed of a polyamide (PA) monofilament mainline, 26 km in length, with secondary lines attached in clusters of six hooks (termed 'baskets') over approximately 360 m. Technical details are given in Hazin et al. (2000). All hooks were baited with uniform-sized squid, *Illex* sp.

In both experiments, the longline gear was deployed each evening between 18:00 and 21:00 h, allowed to soak overnight and hauled back at daybreak (∼06:00 h) of the following morning. A total of six research cruises were carried out. The number of days fished during each experiment was: 15 (three trips; 2094 hooks) for experiment 1 and 15 (three trips; 3732 hooks) for experiment 2. Relative abundance of the species caught was evaluated as nominal catch per unit of effort (CPUE), defined as the number of fish caught per 100 hooks.

The first experimental fishing trial consisted in the evaluation of the effect of the number of chemical light-sticks (small plastic tubes containing two chemical substances, luciferina and luciferase, that produce a fluorescent light when mixed) per basket on the catch rates of swordfish. The experimental design involved the deployment of gear with the following series of baskets: a first basket with six light-sticks (L6), a second basket with no attractor (N), a third basket with three light-sticks (L3) alternating in the hooks and a fourth basket lacking attractor (N). The light-sticks used in both experiments were green, 6 in. in length, and produced a light for 6 h, attaining maximum intensity after 4 h.

Catch rates for gear without attractors and with attractors (chemical light-sticks and electralume) were compared in the second experimental fishing trial by size class of swordfish. Electralumes are characterised as continuous light attractors, consisting of two size AA lithium batteries (or common sodium batteries), producing a light up to five times as intense as that of light-sticks. In this study, green electralumes were used to minimise the confounding effect of colour on swordfish catches.

The catch size-frequency data were distributed in three size classes (lower jaw to fork length (LJFL) in cm) as described by Arocha (1997) and Hazin et al. (2001): (a) <125 cm, immature; (b) 125–170 cm, maturing stage; (c) >170 cm, mature stage.

The gear configuration used was similar to the first experiment with the first basket having three light-sticks (L), the second basket with no attractor (N), the third basket with three electralumes (E) on alternating hooks, and so on consecutively, according to the methods used in the commercial fishery.