# Measurements of Swimming Speeds of Yellowfin Tuna and Wahoo

Bainbridge[1] and Nursall[2] have questioned the validity of certain fish swimming speed estimates because these require that either completely laminar flow or very high power factors must be postulated in order to explain the animals' performance. Speeds in excess of 45 km/h are included in this suspect category. Walters[3] showed that certain morphological features indicate that scombroid fishes may attain velocities of 10 body-lengths/sec, and the large species should be able to attain maximum speeds considerably in excess of 45 km/h.

An opportunity of measuring scombroid swimming speeds arose when the junior author was invited to participate in a tuna behaviour research cruise off the Pacific coast of Costa Rica. The measuring equipment consisted of a spinning rod and a spinning reel containing fishing line marked with iron powder. A magnetic pick-up was mounted near the tip of the rod, so that when a hooked fish pulled line from the reel, the magnetic field was disturbed by the iron powder markings. The resulting electrical signal was fed into a tape-recorder.

The magnetic pick-up consisted of a monaural variable reluctance phonograph cartridge (General Electric Model 4*G*–050) modified by removal of the stylus assembly and mounted in a 1·6 cm × 1·6 cm × 1.6 cm aluminium box (Fig. 1). The line passage was a 1·6 cm length of 2 mm inside diam. plastic tube into which the magnetic poles projected. The entire box, except for the line passage, was then filled with epoxy resin. The recording unit was mounted on the rod, midway between the two distal line guides. The output leads were connected to a portable tape-recorder (Transmagnemite model 612*SDV*(8106)).

Braided linen fishing line of 18- and 27-lb. test was marked at 2·54 cm intervals with powdered iron suspended in collodion and methyl ethyl ketone. A feather or bone

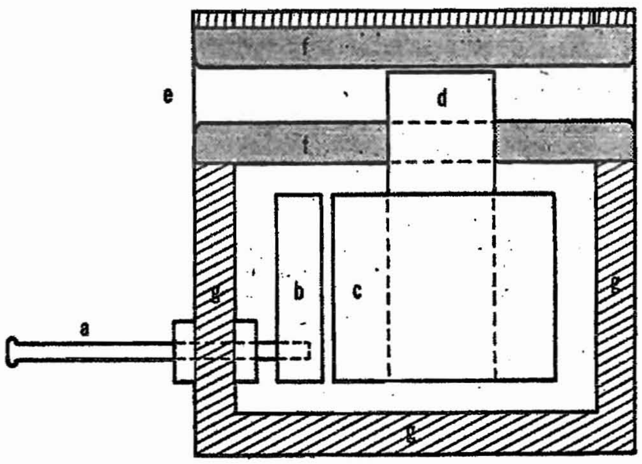


Fig. 1. Longitudinal section through the magnetic pick-up unit. *a*, Output terminal; *b*, magnet; *c*, coil; *d*, magnet pole; *e*, line passage; *f*, plastic tube; *g*, aluminium box

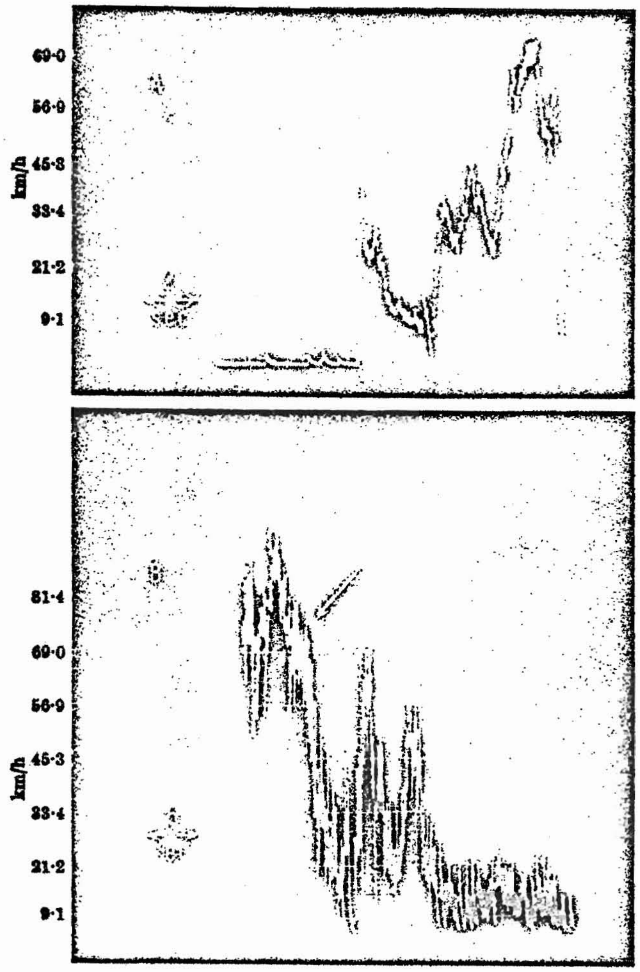


Fig. 2. Example of two oscillograms of swimming speeds *A*, Wahoo *D*; the recording ended abruptly when the iron powder markings were whipped off the fishing line before entering the magnetic pick-up unit. *B*, yellowfin *D*; the arrow indicates the maximum speed chosen after the 5-sec delay

jig attached to a 2-m wire leader was connected to the marked line and trolled behind a skiff. When a fish was hooked, the skiff operator shut off the outboard motor and turned the skiff 90°. The rod was pointed at the fish to minimize the action of the pole. Once the line had passed through the pick-up, it could not be rewound on the reel because the wet markings would scrape off inside the cartridge. It was thus necessary to handline each fish to the skiff, and often a fish either escaped or was attacked by a shark before it could be boated.

Swimming speed measurements of yellowfin tuna, *Thunnus albacares* (Bonnaterre), were only taken in pure yellowfin schools, so the fish were identifiable even though they may not have been seen. The mother vessel was trolling at the same time with similar lures and caught only yellowfin tuna; the size ranges are given for those fish that were brought aboard the larger vessel (Table 1). The larger body sizes were used to calculate the body-lengths/sec.

Table 1. Maximum Burst Speeds for Yellowfin Tuna and Wahoo

| Specimen | Total length (mm) | Burst velocity (km/h) | mph | Body-lengths/sec |
|---|---|---|---|---|
| Yellowfin *A* | 558–870 | 35·87 | 22.3 | 11·47 |
| Yellowfin *B* | 558–870 | 24·86 | 15.5 | 7·95 |
| Yellowfin *C* | 558–870 | 18·83 | 11.7 | 6·01 |
| Yellowfin *D* | 530–980 | 74·59 | 46.4 | 21·11 |
| Yellowfin *E* | 530–980 | 45·25 | — | 12·81 |
| Wahoo *A* | 1,000 | 43·71 | 27.2 | 12·15 |
| Wahoo *C* | 920 | 43·35 | 27.0 | 13·09 |
| Wahoo *D* | 1,131 | 77·05 | 47.9 | 18·93 |

The identification and capture of wahoo, *Acanthocybium solandri* (Cuvier), was easier. On striking the lure, the wahoo always jumped clear of the water and could be identified at that time. They were brought aboard the skiff for measurement.

The recordings were analysed in the laboratory. The tape-recorder output was fed through a rectifier to filter out the background noise and then into a converter (Foxboro model *FR*–73–4) that transformed the variable frequency into a variable d.c. voltage. This voltage was then fed into an oscilloscope that had previously been calibrated with known frequencies. The oscillograph tracings were recorded photographically. Since it took an estimated 5 sec to bring the skiff to a stop, the first 5 sec of each tape-recording were not used for swimming speed measurements.

The highest peaks taken from the oscillograph tracings (Fig. 2) after the initial 5 sec are summarized in Table 1. These burst velocities were present only in the first 10–20 sec after the fish was hooked, after which the velocities dropped to much lower values. The drop in line velocity could have resulted if the fish had changed course; in some cases the line went entirely slack, indicating the fish had indeed reversed its direction.

Other factors that may have reduced the line velocities are the drag of the fishing line, the drag of the lure, and the probable turbulence induced in the boundary layer of the fish by the line and lure. No measurements were made of these values. It is felt that yellowfin tuna and wahoo can probably attain higher velocities than are reported here.

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