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Do Tuna and Billfish See Colours?

Dr. Kerstin Fritsches and Professor Eric Warrant

Introduction

Do billfish and tuna distinguish colours? This question has captivated both fishermen and scientists for years. Proving colour vision in this group of fish is particularly difficult since behavioural colour discrimination experiments—the "final proof" of colour vision ability in any animal—are impossible to undertake with such large open ocean fish. Instead, scientists have aimed to establish if billfish and tuna have the necessary 'hardware' in their eyes to discriminate colours.

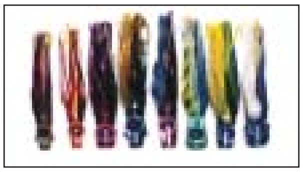

Figure 1. Colourful lures are used to attract billfish and tuna but do these fish actually see colours?

More than 20 years ago two different approaches (pigment extraction by Munz and McFarland 1977 and electrophysiological recordings, Tamura et al. 1972, and Kawamura et al., 1981) were used to try to identify the potential for colour vision in billfish and tuna. Neither technique produced any evidence of potential colour vision in either tuna or billfish. This was considered surprising since billfish and tuna live in a mostly brightly lit and colourful world. However, since these early studies our knowledge of colour vision in fish has greatly improved as have a number of techniques used to study colour vision, especially measuring colour sensitivity using microspectrophotometry (MSP). Using this technique, many fish have now been identified as having supreme colour vision potential (ie. Bowmaker, 1995).

In our current project we found strong anatomical evidence for colour receptors, known as cones, in the marlin eye (Fritsches et al., 2000, 2003a). Hence we decided to reinvestigate the question of colour vision in billfish and tuna using MSP. We have been able to collect suitable tissue both during cruises on the NOAA ships

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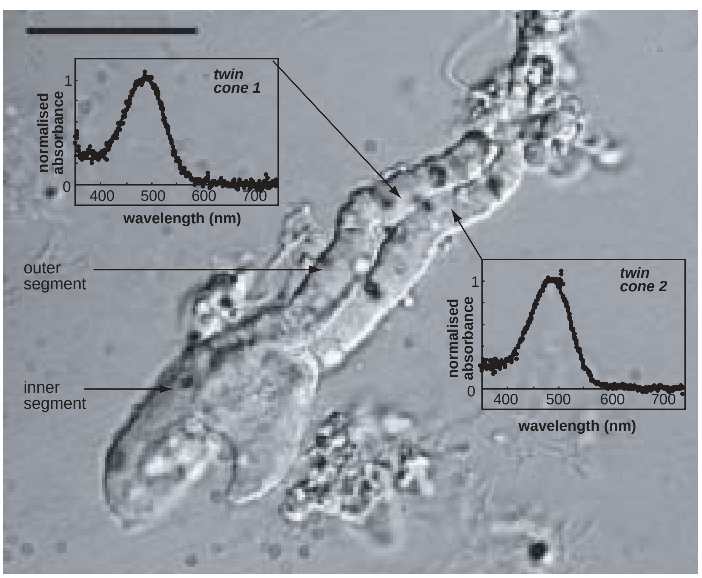

Figure 2. Photograph of a bigeye tuna twin cone showing the inner and outer segments and the absorbance curves of each member of the twin cone. Both cells have identical colour sensitivities with a lmax at 488nm (scale bar 20µm).

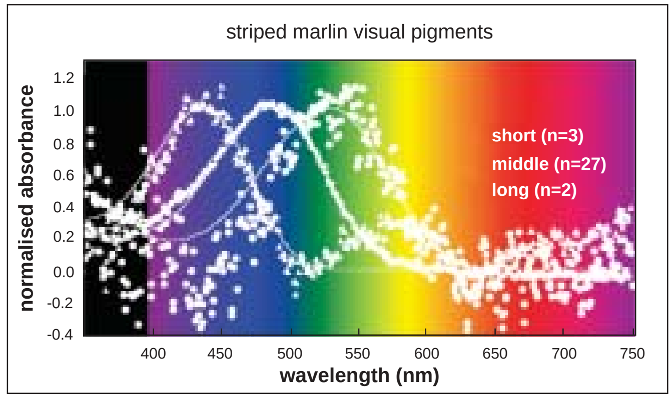

Figure 3. Position of the three visual pigments in the blue marlin with respect to their colour sensitivity. The colour panel illustrates approximately the colours seen by humans at the different wavelengths.

CONTENTS

Townsend Cromwell and *Oscar Sette* and with the assistance of recreational fishermen on the East coast of Australia. Samples of billfish and tuna were measured using the MSP set-up at the University of Western Australia, Perth, in collaboration with Drs. Julia Shand and Nicole Thomas.

As a result of this work we found the first evidence to date that the striped marlin at least has the necessary 'hardware' for colour discrimination in the form of three distinctly different visual pigments in its photoreceptors (Fritsches et al. 2003b). We were also able to measure the main visual pigments in four other pelagic species—swordfish, bigeye tuna, yellowfin tuna and sailfish. The major visual pigment of all these species is well suited to light in deep and shallow water.

How does MSP work?

Photoreceptors in the eye are designed to collect light information in the form of light particles (photons) and translate this information into electrical impulses, which can be interpreted by the nervous system. All photoreceptors contain visual pigments, which are sensitive to a particular wavelength (or colour) of light. This means that more photons of one wavelength are absorbed than of any other wavelength. If the retina contains different classes of cone photoreceptors with visual pigments tuned to different wavelengths, there is the basis for colour discrimination.

Using an MSP we can determine the preferred wavelength of individual photoreceptors. However this can only be done if the tissue is collected from the eyes of freshly killed fish that had little exposure to light, a challenge when working with billfish or tuna. A microscopic beam of light is directed through the light-gathering outer segment of the photoreceptor. The beam of light changes its wavelength step-by-step and a sensor records how much light at each wavelength is absorbed in the cell. The preferred wavelength of the individual photoreceptor is found where the absorbance of the cell peaks (the lmax, see Figure 2).

A Basis for Colour Vision in the Striped Marlin

In the retinas of two striped marlin we found three different visual pigments. The double cones mainly contain a middle-wavelength pigment with a lmax of 487nm (sensitive to blue-green) while the single cones reveal a shorter pigment at 437nm (sensitive to violet-blue). The retina of the striped marlin surprisingly contains a third visual pigment which peaks at a longer wavelength with a lmax of 528nm (sensitive to green). This third pigment is most likely housed in one of the two cells of an uneven double cone, with the other partner containing a 487nm pigment. We were not able to determine the colour sensitivity of the rods—the receptors specialised for night vision—in this species.

What Does This Mean?

The presence of three visual pigments clearly indicates that the striped marlin has the 'hardware' necessary for colour discrimination. It is also interesting that the three pigments are only present together in the ventral part of the eye which looks up to the brightly lit and more colourful environment above the animal (Figure 4). Discriminating colours requires bright light and the three pigments are optimally positioned for colour vision.

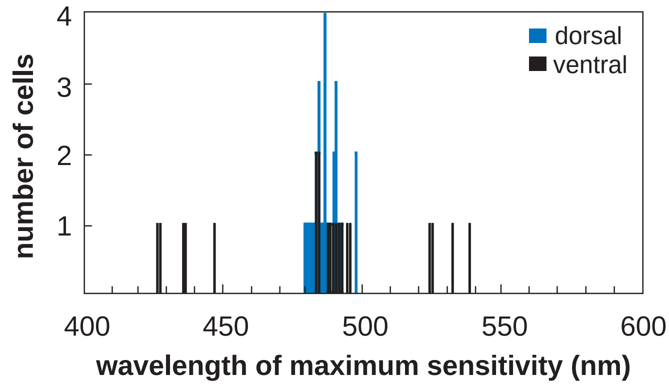

Figure 4. Distribution of the visual pigments within the striped marlin retina found in this study. Both short and long wavelength visual pigments are only present in the part of the retina which looks up into the bright light.

The part of the eye looking down into the darker water below the fish, contains mainly the middle wavelength, blue-green sensitive pigment (lmax 487nm). This pigment is perfectly matched to the colour of the prevailing light in deeper water, allowing the fish to 'catch' as much light as possible in deeper, darker waters.

The fact that these pigments were not found with the pigment extraction technique by Munz and McFarland is not surprising since this method is less specific and sensitive than MSP (McFarland, personal communication). However, it is more puzzling that the electrophysiological recordings did not reveal the visual pigments present in the striped marlin. A possible explanation could be that only a relatively small number of cells were tested in this species and the authors, probably unaware of the differences in cone distribution between dorsal and ventral retina, did not specify which area of the eye they tested. Using the new evidence of different visual pigments described here we will also use electrophysiological methods to clarify this present discrepancy.

But does the presence of three visual pigments mean striped marlin can discriminate colours? Different visual pigments located in different photoreceptors are a prerequisite for any colour vision system, so the striped marlin definitely possesses the 'hardware' for this ability. We will now have to establish whether this colour information is further processed in the eye. However, since we have identified the exact colours the receptors are sensitive to, we can now theoretically determine what colours the striped marlin might see. Given the strong support we have received from our industry partners and the fishing and fisheries communities at large we might now be able to design some behavioural trials, for instance to test fish responses to lures.

Visual Pigments in Deep Diving fish: the Bigeye Tuna and the Swordfish

Both the bigeye tuna and the swordfish have a single cone pigment, with lmax being 488nm in the bigeye tuna and 490nm in the

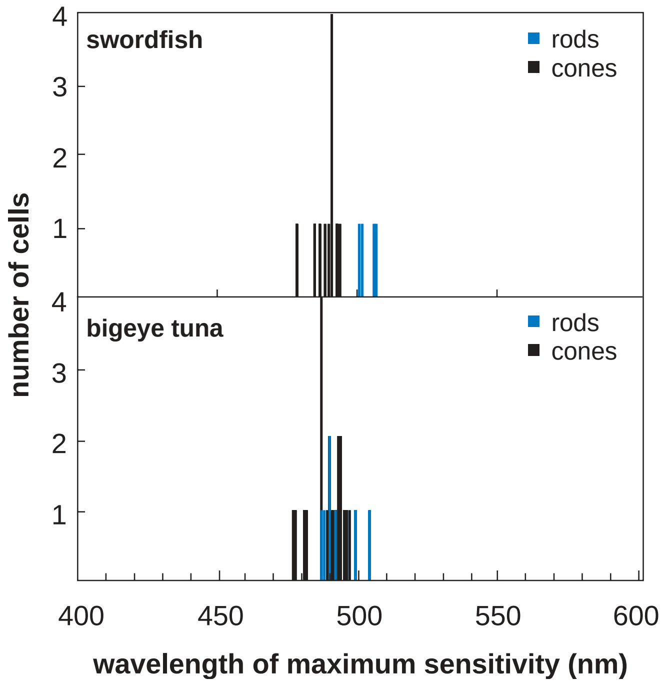

Figure 5. Maximal sensitivities of both rods and cones in swordfish and bigeye tuna.

swordfish. There appears to be a tendency for rods to have their maximal sensitivity at slightly longer wavelength (495nm and 508nm respectively). This needs to be tested further with specimens carefully collected in dim light to avoid bleaching of the small and sensitive rods.

These results will allow us to model visual performance in these deep-water predators, revealing what role vision might play at night and at their newly discovered maximal diving depth of up to 1000m.

Visual Pigments of Tuna and Billfish

In all species measured (bigeye and yellowfin tuna, swordfish, striped marlin and sailfish) the most abundant pigment has a lmax of 488nm (blue-green) and is located in the outer segments of the twin cones. The rods we measured appeared to have their maximal sensitivity at a slightly longer wavelength (492nm), though this difference is still within the margin of error imposed by the measuring technique.

The position of these pigments is perfectly matched to the prevailing light in clear blue, deeper ocean water, suggesting that all species tested have adapted their visual system to optimise light sensitivity at deeper diving depths. So far we have found both short and long wavelength pigments only in the striped marlin, however the quality of this species' samples was considerably better than that of any of the other species and it is likely that other pigments remain to be discovered in these other species as well.

We were also able to measure medium and short wavelength pigments in the yellowfin tuna which matches recent results gathered by Loew, McFarland and Margulies in freshly caught tuna

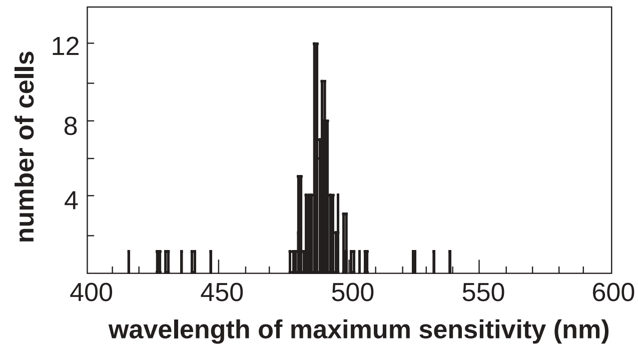

Figure 6. Distribution of visual pigments found in 115 photoreceptors in 5 species of tuna and billfish

(2002). This indicates that the freezing method we used to preserve the retinal tissue did not affect the visual pigments.

Conclusion

These results are very exciting because they reopen the discussion of colour vision in billfish and tuna. The very limited accessibility of suitable specimens has been overcome through the support of the NMFS, the opportunity to work on the *Cromwell* and *Sette* and participation of fishermen on the East coast of Australia. There are still problems to be tackled in relation to obtaining animals in dim light, minimising damage to the delicate visual pigments. However we are very optimistic that we will be able to collect sufficient specimens in the near future to test species-specific differences and regional variations in wavelength discrimination in the different areas of the eyes of additional species.

Together with our collaborator Dr. Richard Brill, we have made good progress in establishing an electrophysiological set-up to study the further processing of the colour signal. This will allow us to test spectral sensitivity, and hopefully collect more evidence for colour vision in pelagic fish.

Acknowledgments

We would like to thank the US National Marine Fisheries Service for financial support and for allowing us access to the NOAA ships *Townsend Cromwell* and *Oscar Sette* which was crucial for the successful collection of tissue. In Australia the generous support of the GFAA R&D Foundation and Tailored Marine Accessories made the early stages of this project possible, jointly funded with the Australian Research Council. Specimens for this work were also kindly provided by Evan Jones and his crew. Lastly we would like to thank our colleagues and advisors in this study, Julia Shand, Nicole Thomas, Nathan Hart, Julian Partridge, Justin Marshall, Julian Pepperell and Rich Brill.

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(continued on page 4)

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PFRP

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Seeking Responsible Commercial Fishing Solutions in Costa Rica

Study Tests New Bait to Reduce Accidental Capture of Sea Turtles

Early last December two Costa Rican longline commercial fishing vessels steamed out of the Pacific coast town of Playa del Coco beginning a series of two-week fishing and research expeditions. Biologists began testing bait which may reduce accidental capture of untargeted species (bycatch)—specifically, endangered sea turtles caught on the hooks of commercial longline fishing vessels.

National Marine Fisheries Service biologists, working with fishermen onboard the longline vessels, dyed the bait blue to determine if it reduces the capture of sea turtles while maintaining high catch rates of mahi mahi, the targeted fish species. Researchers hope to determine if blue dye makes the bait less visible to species such as endangered sea turtles and sea birds, which apparently rely more on sight than smell, to find food.

"Longline hooks capture any species that eat the bait, and we aim to find out if blue bait will reduce capture of endangered sea turtles and other bycatch, without affecting the capture of targeted species," said Randall Arauz, director of PRETOMA (Programa Restauración de Tortugas Marinas: www.tortugamarina.org).

Designed by researchers in Hawai‘i, where similar studies have been conducted on commercial longline vessels, the study in Costa Rica is funded by a grant from the Pelagic Fisheries Research Program at the University of Hawai‘i and the National Marine Fisheries Service. Costa Rican commercial longline fishermen, PRETOMA and the Sea Turtle Restoration Project, a U.S.-based marine conservation non-governmental organization (NGO), are collaborating on the project. Dyed-bait testing, as well as hook and fishing gear modifications, have also been conducted in the Atlantic Ocean.

Costa Rica’s vessels fish mainly for mahi mahi in their EEZ, using squid as bait that is dyed blue in a non-toxic, natural food coloring. Sea turtles apparently avoid blue-dyed food in laboratory studies and researchers hope to determine if they also avoid blue-dyed bait in the wild.

Lines of hooks stretch 30-40 kilometers behind the longline vessel with hooks approximately every 10 meters. The bait type (dyed blue or "natural") were placed on either boat’s hooks on randomly selected days, so that the boat fished one day with all blue bait, and fished on a different day will all untreated bait. At the end of the study, eight 2-week expeditions, data will be analyzed to determine how effective the blue bait is at attracting targeted fish while reducing the capture of bycatch.

Preliminary observations filed from San Jose, Costa Rica, after the first two-week study suggest a few minor adjustments in methods and procedures are needed for the next cruises set for the end of January. These include allowing the two study vessels to ply different fishing grounds; use and dye of preferred bait, such as wild squid, frozen Chilean squid, blue sharks, thresher sharks, skipjacks, sailfish and small yellowfin tuna; and use of a more robust tint of blue dye.

"Nobody wants to see endangered sea turtles and other bycatch species caught on the hooks," said Jorge Ballestero, vice president of PRETOMA. "It’s great to see fishermen, researchers and conservationists collaborating to find solutions to reduce bycatch, reduce impacts on the ocean ecosystem and maintain the profitability of the fishing industry."

PFRP

Developmental Changes in the Visual Pigments of the Yellowfin Tuna, *Thunnus albacares*

Ellis R. Loew, William N. McFarland, and Daniel Margulies

Introduction

Scombroid fishes are highly active predators of the open oceans that rely mostly on vision to detect, track and capture prey (Magnuson, 1963). The retina in tunas is highly developed having rods, single and double cones (Margulies, 1997). The major visual axis is directed upward and visual resolution along this line of sight is the highest known in teleost fishes (Tamura and Wisby, 1963; Nakamura, 1969). Visual acuity is also excellent along the other lines of sight and likely provides tuna with balanced vision in all directions (Tamura, 1957).

Figure 1. Adult yellowfin possess multiple visual pigments in their retinas. (Photo: W. Boyce, 2000)

Previous studies have suggested that adult tunas have only two visual pigments in their retinas—a rod pigment with a wavelength at maximum absorbance (lmax) around 485 nm and one with similar lmax in both twin and single cones inferred from extraction data. Thus tunas have been considered cone monochromats

(continued on page 6)

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Upcoming Events

2004 Ocean Research Conference
February 15-20, 2004, Hawai‘i Convention Center, Honolulu, Hawai‘i
Co-chaired by Russ Moll, California Sea Grant Program, University of California at San Diego, and Charles Trees, Oceanography Program, NASA. Heading the local organizing committee is David Karl, Department of Oceanography, University of Hawai‘i. Contact: Jenny Ramarui at info@tos.org or Helen Schneider Lemay at helens@sgmeet.com. Online information: http://aslo.org/honolulu2004/

Annual South Pacific Tuna Treaty Formal Consultations
March 1-5, 2004, Tuvalu
Sponsored by the National Marine Fisheries Service, International Fisheries Division. Online information: http://www.nmfs.noaa.gov/sfa/international/2003

Quantitative Ecosystem Indicators for Fisheries Management, International Symposium
March 31-April 3, 2004, Paris, France
Web page: http://www.ecosystemindicators.org

Preparatory Conference for the Establishment of the Commission for the Conservation and Management of Highly Migratory Fish Stocks in Western and Central Pacific
April 19-23, 2004, Bali, Indonesia
Online information: http://www.ocean-affairs.com

55thTuna Conference
May 24-27, 2004, Lake Arrowhead, California,
Web page: http://swfsc.ucsd.edu/tunaconf.html

Standing Committee on Tuna and Billfish (Comité Permanent sur les Thonidés et Marlins), SCTB
August 9-21, 2004, Majuro, Marshall Islands
Web page: http://www.spc.int/OceanFish/html/SCTB/

Northwestern Hawaiian Islands Science Symposium
Rescheduled: November 1-4, 2004
Sponsored by the Western Pacific Regional Fishery Management Council.
Web page: http://www.wpcouncil.org/

and, therefore, color blind (Kobayashi, 1962; Tamura et al., 1972; Niwa et al., 1975; Kawamura et al., 1981).

In spite of the above studies, it is possible that adult scombrids are not really isochromatic/monochromatic (Figure 1). They have two morphological classes of cones—twins and singles. We know of no cases where less than two visual pigments have been found in fish retinas containing two or more morphological classes of cones. Certainly single cones can contain the same visual pigment as a member of a twin or double cone, but in these cases there will be a second class of single cone containing a different visual pigment even if it is morphologically identical to the other single cone class. Fritsches et al. (2000) used similar arguments to support their view that billfishes, which have retinas similar to the scombrids, have the capacity for color vision.

Even if adult scombrids are isochomatic/monochromatic, this need not be the case for the larval and juvenile stages (Figure 2). Recent studies reveal that larval fish often possess short wavelength absorbing visual pigments, not present in the adults, that under certain conditions could increase the contrast of small, transparent planktonic prey (Britt et al., 2001). Since scombroid larvae are obligate visual planktivores (Margulies, 1997), might they also possess short wavelength sensitive cones subserving planktivory?

To address these questions, we conducted a microspectrophotometric (MSP) study of retinal photoreceptors from larval, juvenile and adult yellowfin tuna. The study was conducted during 2001-2002 at the Inter-American Tropical Tuna Commission (IATTC) Achotines Laboratory on the Pacific coast of Panama (7º25' N latitude, 80º11' W longitude). The data presented here were summarized in a recent publication (Loew et al., 2002).

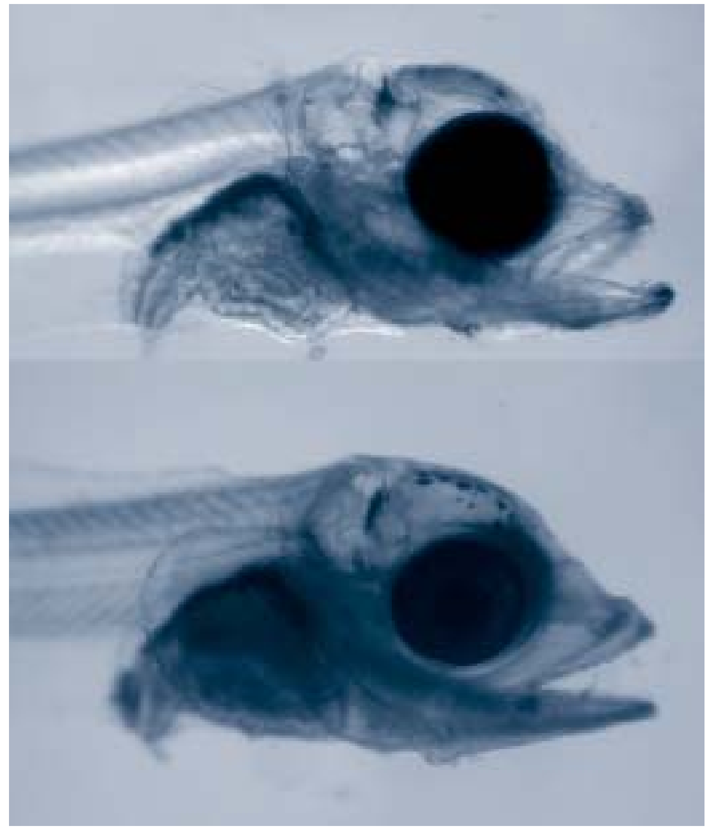

Figure 2. Spectral sensitivity may play an important role in determining feeding success (top-starving, bottom-full gut) in yellowfin larvae. (Photo: E. Loew, 2001)

Visual pigments of adults

We easily identified the three previously reported photoreceptor cell types in the adult yellowfin retina— rods, identical twin cones and single cones. The rods contained a visual pigment with a lmax located at approximately 483 nm (Figure 3). The visual pigments contained in either member of the twin cones had identical lmax located at 485 nm, whereas the single cones contained a different, short-wavelength absorbing visual pigment lmax 426 nm (Figure 3).

The finding of a 485 nm visual pigment in all twin cones and a 483 nm in the rods supports the findings of past electrophysiological and extraction studies. However, our results indicate that the single cones of yellowfin do not contain the same visual pigment as the twin cones. Rather they contain a previously unreported violet pigment with lmax at about 426 nm.

Ontogenetic change of visual pigments in larvae and juveniles

The spectral sensitivity of larvae and juveniles is different from that of the adults. The all single-cone retina of preflexion larvae (3.2 to 4.5 mm SL) shows a wide distribution in individual cone absorbances, containing not only mixtures of the two adult cone pigments (with lmax at 425 and 485 nm), but at least a third green-sensitive pigment with lmax greater than 560 nm (Figure 4). With growth, the longer wavelength visual pigments disappear in the early juvenile stages and variation in cone absorbances decreases with convergence to the adult condition with lmax at 426 and 485 nm (Figure 4).

Ecological Considerations

Researchers have generalized that blue spectral sensitivity in adult tunas was adaptive because it matched the bluish-green color of the seas in which tunas live. The spectral position of the lmax was viewed as an adaptation that would maximize the visual contrast of targets when silhouetted against the downwelling light viewed at depths where tunas cruise and search for prey (McFarland and Munz, 1975). The function of the violet cones that we have observed in adult yellowfin is obscure but open to speculation. It is possible that yellowfin (and other tunas) possess limited hue discrimination in the blue-green to violet regions of the spectrum. The violet-sensitive cones are associated with the major optical axis—i.e., directed toward the sea surface. The presence of a violet absorbing visual pigment does not negate the earlier suggestions that tunas are color blind, but certainly tunas should no longer be considered isochromats.

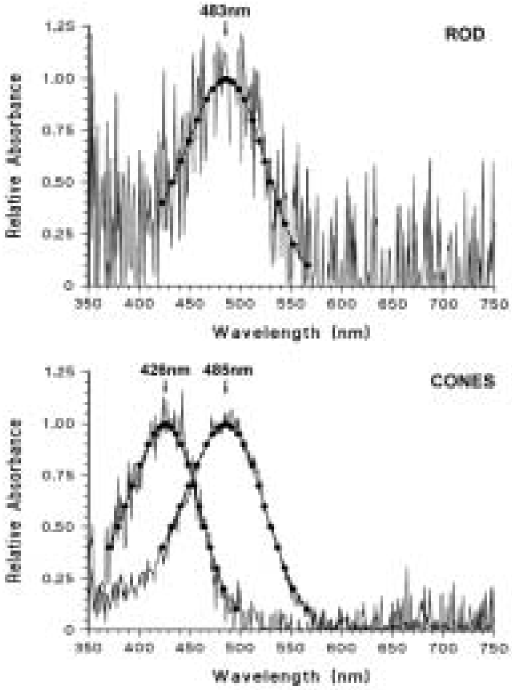

Figure 3. Typical normalized spectral absorbance curves from the photoreceptor cells of adult yellowfin.

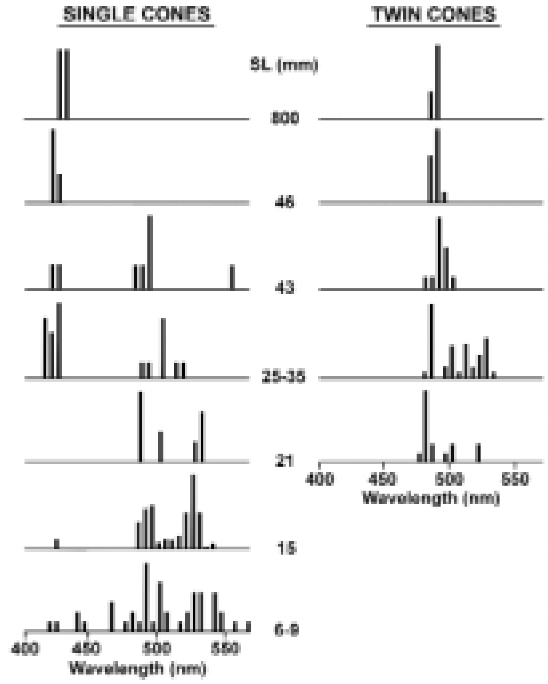

Figure 4. The frequency distribution of peak absorbance of single and twin cones at the standard lengths (SL) indicated for yellowfin.

We suggest that the extended range of larval yellowfin pigments from approximately 420 to 560 nm enhances the detection and capture success of zooplankton, particularly in mixed layer habitats which contain not only a violet and blue spectral range but also a reasonable flux of green and yellow photons. Tuna larvae are diurnal, visual planktivores. First-feeding larvae consume mostly copepod nauplii and copepodites, but quickly shift to larger copepods and eventually fish larvae (Uotani et al., 1981; Margulies et al., 2001). UV- and violet-sensitive cones in larval fish are viewed as a specialization for planktivory (Britt et al., 2001), but we also find the presence of green-sensitive cones correlating with planktivory in yellowfin. The multiple visual pigments of larval yellowfin, particularly the long wavelength pigments, may function to "improve" the detection and capture of small microzooplankton prey, especially if the prey exhibit increased contrast in the long wavelengths relative to background (e.g., they contain chlorophyll-a). As older larvae and early juveniles switch to a piscivorous diet and increase their depth distribution for foraging (into a blue-dominated photic environment), there is a coincident convergence of spectral sensitivity to the adult condition.

The next phase of this research will involve expanded MSP studies of juvenile and adult yellowfin (and hopefully other tuna species), as well as carefully controlled visual behavior experiments on the early life stages of yellowfin.

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(continued on page 10)

WCPFC Shapes Up in Rarotonga

Fifth Preparatory Conference for the Establishment of the Commission for the Conservation and Management of Highly Migratory Fish Stocks in Western and Central Pacific, September 29–October 3, 2003

John Sibert

The Multilateral High-Level Conference (MHLC) concluded on September 5, 2000 with the signing of the Convention on the Conservation and Management of Highly Migratory Fish Stocks in Western and Central Pacific. Simultaneously with the signing of the Convention, the MHLC adopted a resolution creating a Preparatory Conference for the Establishment of the Commission for the Conservation and Management of Highly Migratory Fish Stocks in Western and Central Pacific.

The primary tasks of the Preparatory Conference are to lay the administrative foundation for the Commission, and, if necessary, to recommend conservation and management measures during the period between the signing of the Convention and its entry into force.

The fifth session of the Preparatory Conference, held September 29 to October 3, 2003, in Rarotonga, Cook Islands, hosted representatives from Australia, Canada, China, Cook Islands, European Community, Federated States of Micronesia, Fiji, France, French Polynesia, Indonesia, Japan, Kiribati, Republic of Korea, Marshall Islands, Nauru, New Caledonia, New Zealand, Niue, Palau, Papua New Guinea, Philippines, Samoa, Solomon Islands, Chinese Taipei, Tonga, Tuvalu, United States of America, Vanuatu and Wallis and Futuna.

The Russian Federation attended as an observer in accordance with the decision of the Conference recorded in WCPFC/PrepCon/12. Observers from the South Pacific Forum Fisheries Agency (FFA), the Forum Secretariat, the Food and Agriculture Organization of the United Nations (FAO), the Inter-American Tropical Tuna Organization (IATTC), the Pacific Community (PC), the South Pacific Regional Environment Programme (SPREP), and the University of the South Pacific (USP) also attended.

The Convention will enter into force after ratification by three states north of 20º north latitude and seven states south of 20º north latitude. Alternatively, if within three years of the adoption of the Convention (September 2003), the Convention will enter into force six months after the thirteenth ratification. No states north of 20º north latitude have ratified the convention, but as of October 1, 2003, 10 instruments of ratification or accession had been deposited by states south of 20º north including Australia, Cook Islands, Federated States of Micronesia, Fiji, Kiribati, Marshall Islands, Nauru, Papua New Guinea, Samoa and Solomon Islands.

It is widely believed by PrepCon attendees that the required number of ratifications will be deposited for the Convention to enter into force in mid-2004. In other words, the work of the PrepCon in creating a functional commission needs to be completed at its next session.

The official work of the PrepCon is conducted by its three working groups: WG-I, organizational structure, budget and financial contributions (chaired by Lucy Bogari, Papua New Guinea); WG-II, scientific structure and provision of scientific advice (chaired by John Kalish, Australia); WG-III: Monitoring, control and surveillance (chaired by Bill Gibbons-Fly, U.S.).

Working Group I: Organizational structure, budget and financial contributions

Discussions of WGI focused on how to finance the Commission. Previous session of the Preparatory Conference agreed that financial contributions would be comprised of a base fee, a national wealth component and a variable production fee. The principle points of discussion were the method of computing national wealth and the relative proportions of the three components.

There was some agreement that the national wealth component should also make due allowance of the state of development of the member and its ability to pay. A revised formula was considered that gave equal weighting of gross national income (GNI) per capita and GNI. Although there was no consensus on relative proportions of the contribution components, there was general preference for a relative weighting of 10/20/70.

In the interest progress on other matters this scheme will be used for the purposes of preliminary budgetary planning and the matter taken up at the next session of the PrepCon. In all formulas given serious consideration, Japan, United States, Taiwan, and Korea collectively contribute approximately 65% to 70% of the total budget.

Determining the organizational structure of the Commission secretariat and its provisional budget are major tasks of the WGI. Resolution of these issues depends on final determination of the science capability of the Commission and how the Commission will conduct its monitoring, control and surveillance functions. Since the working groups for science and MCS have not yet completed their work, WGI agreed that, at its next meeting, it should address in detail matters relating to the structure of the Commission Secretariat, the provisional budget for its early years, and how such a budget may be financed.

Working Group II: Scientific structure and provision of interim scientific advice

WG II did not meet during PrepCon 4, and therefore had a substantial workload, meeting for three half-day sessions in Rarotonga. The major issues before WGII were the organizational structure of the scientific functions of the Commission and scientific advice on the status of stocks in the Western and Central Pacific Ocean (WCPO). WGII delegates most technical issues to the Scientific Coordinating Group (SCG) a group of scientists from Commission members. The report of the second meeting of the SCG provided sufficient guidance to WGII that substantial progress was made on key issues.

WGII opted for a flexible and adaptable scientific structure for the "transitional period," i.e., the first few years of operation of the Commission. The initial scientific staff is small, consisting of a science manager, database manager and observer coordinator. Most of the scientific and data management activities will be conducted under contract to the Secretariat of the Pacific Community Oceanic Fisheries Program (SPC/OFC) during the interim period. Use of the OFP in this fashion enables a smooth transition from the current arrangements into the new commission and makes efficient use of existing regional organizations, major issues for some commission members.

The Commission will compile and maintain the following annual catch estimates by species and gear, size composition data, operational (set by set) catch and effort data, unloading or transshipment data, port sampling data, observer data; gear and vessel attribute information, and other types of data required for research purposes. These data will be collected directly from Commission members or indirectly though cooperation with coastal states and will be collected from both on the high-sea areas and from exclusive economic zones (EEZs). The operational level data will help ensure that Commission stock assessments are based on the most complete data possible.

WGII generally adopted the conclusions of the SCG regarding status of stocks. In particular WGII noted that the assessment results for bigeye and yellowfin may require PrepCon to consider how to implement management measures to address over-fishing and alleviate over-fished stock conditions. However, neither WGII or PrepCon as a whole was able to specify what management measures might be appropriate. WGII also noted the uncertainties in the stock assessment and endorsed plans for improving data collection systems in Indonesia and the Philippines.

Working Group III: Monitoring, control and surveillance

Most of the work of WGIII focused on developing guidelines for boarding and inspection. The issue under discussion was whether, and under what circumstances, a fishing vessel of one Commission Member might be boarded by enforcement officers of another Commission Member. While no consensus was reached, the exchange of views reveals some areas of general agreement that will be formalized into draft rules to be presented at the next meeting of the PrepCon. WGIII will also have to consider observer programs, vessel registry, vessel monitoring systems, and vessel and gear marking at PrepCon6.

Northern Committee

The Northern Committee has been a contentious issue since it was introduced into the MHLC treaty negotiations. There were concerns about fragmenting the authority of the Commission, discrepancies in rules of procedure, and areas and stocks of concern to the Northern Committee. Intense discussion and informal consultations between delegations resolved most outstanding issues in relation to the Northern Committee. The agreements reached are reflected in revisions to the draft rules of procedure and will be formally adopted by the first meeting of the Commission. This agreement was seen as a major accomplishment clearing the way for ratification by members north of 20º north latitude.

Conclusion

PrepCon 5 made substantial progress. Agreements on the structure of the science secretariat and the data to be collected by the Commission are major steps toward an effective commission. Agreement on the rules of procedure for the Northern Committee clears the path for northern Members to ratify the treaty.

A substantial remaining hurdle to creating an effective commission is finding the means to finance it. The WCPFC will have jurisdiction over the largest fishing ground in the world and the responsibility to manage a fishery worth over one billion dollars annually. Members are rightly concerned about keeping costs down, yet the provisional budgets discussed to date amount to less than 0.5% of the landed value of the catch.

The next session of the Preparatory Conference will take place in Bali, Indonesia, from April 19-23, 2004.

All papers and working group reports from the Preparatory Conference can be obtained from the WCPFC web site http://www.ocean-affairs.com

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Publications of Note

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Representatives from around the world attended the fifth session of the Preparatory Conference for the Establishment of the Commission for the Conservation and Management of Highly Migratory Fish Stocks in Western and Central Pacific from September 29 to October 3, 2003, in Rarotonga, Cook Islands. Online information can be found at http://www.ocean-affairs.com.

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