


Notebook #14



Made in U. S. A.  
THIS BOOK CONTAINS EYE-EASE PAPER  
*"Easy on the Eyes"*



Carboys w. outlets on bottom for elec. etc.  
Plastic/air lift filters w. glass wool  
Saran plastic tubing - Elmer Mills Corp. Chicago

2/5/8 3/45 Benini  
Crushed optos - food

Goby = *Cathogobius soperi* ✓

Must-Silly

Parrot fish = *Sparisoma radians* ✓

Whauer

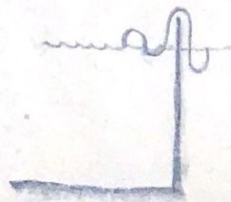
King Slippery Dick = *Thalassoma bifasciatum* ✓

Pink Slippery Dick = *Iridio bivittata* ✓

Beau Gregory = *Dipomacentrus leucostictus* ✓

Cock-eye Pilot = *Abudefduf analostanus* ✓

Sergeant Major = *Abudefduf saxatilis* ✓





## Optic Nerve Regm

Blinded bilaterally by crushing the optic nerves repeatedly with blunt forceps. Made slit in conjunctiva postero-laterally & rolled eye till saw op. n. Crushed close to eyeball in most cases. Used 1 cc of chloroform in about 4000 cc of water if remained while still kicking & held down under a towel.

- 2-30-48 Grunt <sup>about 7" long</sup> Haimaloma sciurus w. blue stripes over head  
3-1-48 Angel, File, Pang, Queen Trigger Balistes vetulus  
& Lane Snapper dies Acanthurus bahianus

None show any signs of vision - detect presence of wandering objects however, probably by lateral line. They stay still in one spot, when stirred up, tend to bump into wall, & don't go after food or run at shadows & app.

Dr. Breder says they act like blind fish. They all became quite dark after a few days.

- 3-11-48 signs of recovery in the Grunt. (has record) All of the others are still in very black phase, except the File fish



3-15-48 (Tank 1) Abundantly shows possibly slight  
optokin. R. but it is not certain & this is within error.  
In 4 gobies the optokinetic R's are extremely poor or absent.  
Only 1 S-D showed definite op. R's as observed.  
On whole these cases are not convincing of the  
orderliness of prey - as yet at least. I  
got one goby to show det. op. R's 3-17 the S-D's pick up small bits of  
food and chase each other around the tank.

(Tank 2) Pairs of the gobies show correct optokin. R's

3-20-48 Saw very light gobies & a dark one in tank 2.

3-22-48 The gobies in tank 2 generally show  
good localization of bits of pinkish  
liver.

So far orderly prey in all but the  
A- animals & the large fish.

3-26-48 The Tang outside has become light in  
color the past few days but otherwise it  
shows no evidence of vision.



3-3-48

Crushed op. n. on Gobies (4) and

Tank 2

Slippery Dick (3) and Creepered Pilots (2).

Could see nerve nicely in the S-D's and C-E-P's. In the larger C-E-P the nerves were well crushed, almost severed completely.

Added Sergeant Majors (2) both well done. Can see nerves clearly in these + C-E-P's + S-D's and in S-M's both nerves were crushed with partial severance - certainly get fiber intermixing in these + in larger C-E-P.

Tank 2

Added 1 sergeant major very small about 1 inch +  $\frac{1}{2}$  long w. nerves well cut. (Nerves in the small fish are soft + pathways more readily busted by crushing.)

[Nerves of the Slippery Dick are especially far posteriorly + dorsally.]

1 hr. after Slippery Dick - tend to hide, + to cover selves up w. sand.

Sergeant Majors - swim around at surface w. nose almost in air.

Creepered Pilots - swim about at bottom.

Gobies - none about a bit.

All but the S-M's are in a very light phase.

[Added another C-E-P with both nerves completely broken + same excised in tank 2. One hr later he also is in light phase.]

Added in tank 2 another small S-M and 5 small

Gobies

3-4-48 Added a parrot fish to tank 2



3-7-48 1<sup>st</sup> signs of visual recovery in the S-D's.  
They show fright R's to sudden mistle outside aquaria.  
This is only 4-5 days regn time.

3-9-48 Recovery of vision in one of the Gobies  
in tank 2. = 6 days regn time.

3-9-48 Did 3 more large Slip-D's of diff't

species and one Peppert fish in all of  
which the nerves were severely crushed  
w. practically complete severance of  
all fibers.

Tank 4

2 more very small S-D's in standing  
aquarium. The smallest got bleeding on  
both sides. In both cases have practically  
a complete interruption of nerve & its sheath.

A S-D blue head about 2 in long. Red bleeding  
on rt eye - left eye OK. Nerve well severed in  
both. Complete section of sheath on left.

A small S-D pink of about same size. Got  
bleeding on both sides - complete severance of  
nerve on rt & of n + sheath on left.

A larger S-D blue w. both nerves well severed  
bleedg on left only.

" " " " " " " " " " " "

" " rt. only. Left well done. Almost  
exactly same size as precedg.

3-13-48 - Small S-M in tank 2 has recovered (other died) then recovered  
died 3-17-48.

3-17-48 Smallest S-D in standg aquaria shows startle R's to sound  
= 8 days recy time - not as good as the gobies.

3-20-48 Both small S-D's " " show correct op. R's + startle  
R's & smallest is clever as dodg net. = 11 days  
All the gobies in #2 seem to be judg by escape - 2 are  
very light & 3 are med. dark.

3-22- Both small S-D's swim to a small piece of liver and  
can't be other about chasing after. - net off cause swim rt by a  
large bity piece of liver.



3-4-48

180° eye rotation

Rotated eye on one side + out of m.  
on other in a S-M and a Bean Gregory  
Each circled round + round in one spot  
digging a cone out in bottom. They went  
at first a pace  $\pm 75$  circles/minute  
until they collapsed on side of eye. Go on  
toward eye-less side as in amphib. o.

After collapsing they got up again  
after about 10 min. the S-M ~~started~~ <sup>started</sup> ~~of~~  
the other way + kept it up for 5 min.

When returned after dark 1 hr. later the  
Bean Gregory was still  $\odot$  but very slowly  
and the S-M had stopped.  $\odot$  was  
only showing myotomus marks of the  
head and eyes.

Tried a file fish, + a shad, + a parrot fish  
with no effect.

\* Another B-G backs up all time or very slow  
slow  $\odot$  toward eyeless side.  $\odot$  all next day

Another S-M. shows little  $\odot$  except while  
coming out of anesthetic.

The 1/2 grad B-G.  $\odot$  all next day at 40-55/min.

S-M's seem to be more erratic

\* Added some more Gobies w. only one eye  
rotated.



Symptoms of Reversed Vision - & Central

1. Tendency to  $\odot$  toward blind side.
2.  $\odot$  to other side to lesser extent - gobies, Parrot fish,
3. Reversed sp. kin.  $\odot$  in both directions for  
Goby,

Can stop the  $\odot$  of Blue Goby sometimes,  
& reverse to same extent - the colored  
one does this nicely.

The parrot fish backs up when try to reverse  
him - " shows all kinds of pleasure  
contentment, while at great rate when  
gets started.

4. Nystag.  $\odot$  of the central blind eye.
5. Escape Rins are ineffective. Can't say reversed.

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Excised central eye in the gobies 2-22-45

Did a puffer fish 3-17 & next day he rotates  
in which super dir. he happens to get  
going. Circles about  $1\frac{1}{4}$  diam. total length / horizontal  
only as a rudder.

The S-M's. died one on 18<sup>th</sup> & one on 20<sup>th</sup>. The  
smallest Sparisoma died 18<sup>th</sup>. Can't say any  
signs of ad'it in these.

Sometimes the 1st B-G swims in wide  $\odot$  these  
days (3-19) does about 36/min. Jerky turns & stops for moment  
& then swims again & holds it. The one in wide color  
phase does only 20/min. The gobies are all extremely  
dark in this tank. Marked contrast to all other gobies  
except a few blind ones left in 2.

3-21 Pamacentrid as bad as at begg when stirred  
up by food or net, etc.

3-22 Parrot fish no longer  $\odot$  madly when stirred can swim  
pretty straight. Still shakes up muscles of head & of both eyes when at rest.



So far have a no. of Gobies, 2 Beau Gregories, 1 Sergeant Major, and 1 Parrot fish - all showing the typical  $\odot$  toward the blind side after unidirectional eye rotation. The B-G's + S-Ms continue perpetually while the Gobies + Parrot fish come to rest.

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The rotating fish will sometimes eat if they inhale some food on-the-fly. I say they will live for a month + without food. (based on some fish which live in the  $50^{\circ}$ )

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The S-M + sometimes Parrot-fish will show wild gyrations, swim backward in  $\odot$ 's as well as forward and at rest.

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Occasionally a Goby will get up to high speed and show wild frantic  $\odot$ 's for a short period.

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The S-D's + Gobies will come up + pick off a piece of float or sinking food + chase each other around after bil. in region.

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2<sup>nd</sup> Parrot fish ~~was~~ dropp'd on 23<sup>rd</sup> - was still  $\odot$  on 2<sup>nd</sup> the net so bad. Not sure other optic nerve had not reg'd. Reapp'd 3-25

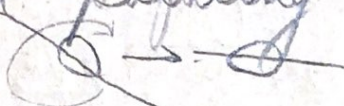
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The 2<sup>nd</sup> Panocentrid after phase of unrotated eye was moved again, began  $\odot$  in other direction but then bumped something + got goby old way again.



Nerve Section with 180° Eye Rotation

3-6-48

— 13 Gobies in tank 4. The eye muscles were extirpated and the nerve well crushed thru a dorsal incision over the orbit. In the first 7 or so the eye was placed pointing a little above the horiz.  i.e. turned a bit less than 180.

The outer corneal membrane is not attached to eye in these.

A 14<sup>th</sup> was done very nicely & the contralateral nerve was also broken & this one put in a separate small aquarium. (Reid on 3-12-48 = 7 days)

In perhaps 4 or 5 of 14 13 there was bleeding when nerve crushed so that circulation of retina may have been cut off. [Eyes turn black later in some <sup>(4-5)</sup> cases]

[This Goby is the saparohata? & its <sup>light, red, etc.</sup> iridial color Δ's pretty well obscure the background matching.]

The contralateral nerve will have to be sectioned before they recover.

This Goby = Rathygobius saperata.



3-7-48 Put a 15<sup>th</sup> case in w. #14 in which the left op. n. was severed and the right eye had been rotated but no vision afterward. Next day this case shows pronounced circling (+ sometimes goes the opposite direction altho there R's to the seeing side are somewhat ~~less~~ weaker than those toward blind side.) Both of these eat well.

The case w. spont. O<sub>g</sub> shows little or no impaired op. R's, however.

The Parrot fishes also @ in both directions tho more vigorously to the blind side.

When the Goby gets going in the typical dir'n, he may keep it up for 5-10 mins. seems to be an inertia effect.

3-13-48 Spontan optokinetic R's in #14 = 6 days recovery time.

This series ranges in length from 2-6.25 cm.

3-22-48 Removed the contralateral eye on the whole series. There had been some slight turning R's in some of the cases indicating recovery. All were in very light phase.

Imbed. after op'n they began going in @ either or both directions. All cases read, includg the largest, except possibly 2 med. sized lanes, which kept apart & unatched.



These were able to get along fine w. the unil. resp. mission. Swam up & picked off pieces of food, etc. before removal of other eye.

So / minimal resp in the bunch in 16 days - between 6 + 16 days w. younger a bit earlier.

[∴ better material than the frog + newt.]

3-23-48 The 2 excepts show strong O<sub>2</sub> R's today so all do by the 17<sup>th</sup> day.

All but a couple of them (one the largest) have started to turn dark. Are greyish today.

3-26-48 About 5 show def. optok R's in reverse. The rest not, altho some of these show strong O<sub>2</sub>. Again it looks as tho' the optok. R's are not very good. Animals freeze - stick to sides, get turning one way + keep going that way, etc. R. is not as "compulsive" as in amphib. so.

These should have op. R's tested again at a later date.



## Eye Transplants

- 3-9-48 Six good-sized Gobies about 2 in. long. Reimplanted the right eye leaving left intact. Next day three have black eyes while others return grey-brown pigmentation.
- 3-10-48 Added 10 more smaller ones and put them all in one large tank in "dark" room. Can clean out the orbit very nicely w. piece of kleenex so no clotted blood left. Rotated eyes  $180^\circ$  in a few of them but most are right side up.
- (In one of these cases did not pull eye all the way out of orbit + a m. w. bl. w's may have been left intact)
- 3-20-48 The eyes have been very dark up till now but now they are begining to clear up and look same as good eyes.
- 3-22-48 They <sup>(are)</sup> are all pretty well cleared up now. (Remained 1 dead one).
- 3-24-48 Extirpated the other eye in all cases. They showed a good deal of O<sub>2</sub> after coming out of spec. at close quarters. But there was no swelling of the head & diameter of O<sub>2</sub> not quite so small as in barefield op. O<sub>2</sub>. They were all in med-light phase before op.



3-24 Next day they do not show any  
O<sub>2</sub> in their skin tank - appear to be  
blind still. whereas the cases w. 180+  
sp n. division do show O<sub>2</sub> back in their  
own tank.



Survival Times on Cases w. Rotated  
Eyes & Effect of Experience.

Parrot fish - smaller died on 12<sup>th</sup> day (no sept)  
Two S-Ms - died on 14<sup>th</sup> + 16<sup>th</sup> days

These two circled more slowly perhaps  
the may have been lack of energy. Same  
suggin that they could attend to other  
things besides O<sub>g</sub> to a limited extent.  
These two were sort of superimposed upon  
the O<sub>g</sub> - but only a suggin.

The B-Gs on 20<sup>th</sup> still O<sub>g</sub> steadily slow reverse  
to approach of food (away) + net (toward).  
The dark one will not leave bottom to go up  
into a net. The blue will to some extent  
after net gets far down around him. The  
puffer will circle up a bit but not very much.  
Maybe he's still too concerned about O<sub>g</sub>.

On 20<sup>th</sup> Puffer is O<sub>g</sub> toward seeing side

3-25-28 1<sup>st</sup> Panacentrid died w out evidence of  
readjt in O<sub>g</sub> - not sure there was none of  
superposed upon the O<sub>g</sub>.

Panacentrid O<sub>d</sub> toward seized for while  
when coming out of anaesthesia on 27<sup>th</sup>



## Flounder's V-O system

The foot-long Fluke (*Pareuchthys* <sup>probably undulatus</sup> -----) shows very nice compensatory eye movements in all 3 planes. (Tested by catching him in net & rotating while he was still in net.)

Repeated & again got compensatory eye movements to tilting the 3 primary planes.

They don't wobble much up & down when swimming at slow speed.



## Possibilities, notes, Etc.

### Schedule:

- ① op. n. regin in large & small & in assorted species. Test/regen. ty of e.N.S. and at same time " orderliness of recy.
  - ② Inmed. effects of eye rotation & possibility of reeducation in fish. There are a no. of references & stuff can cite to show superiority of fish over amphibians. (May get ppr out of this)
  - ③ If any show signs of regin, rotate eyes before recy in remainder.
- 
- ④ Conditioning and effects of brain lesions.
  - ⑤ Setting up for reflex studies w. elect. Stim.
  - ⑥ Flounder situation



Fish w. extensive eye muscles tend to have op. n. arising from dorsal quadrants & in these can spread nerve equally - avoiding the artery.

Slip-Dicks have nerve arising posteriorly. The outer corneal membrane is attached to the eye in many - tho aptly not in the Gobies.

There is still a lot of eye muscle in the eyes w. severed op. n.s

Contrary to all other species, the tide-pool types seem to turn light after op. n. section.

The op. n.s are much larger than in amphibs.

The peculiar long crawling shrimp has mounted eyes that he points around in all directions and rotates at the same time.

Parrot fish optic nerves are very large and very accessible arising out of dorsal quadrants. They will turn eye way around till it faces rear.

[ Micro-*Sim* of the op. lobes of large Parrot fish might yield something ]  
S-Dp do just about as well in this respect. These fish lie motionless at bottom & keep casting eyes <sup>around</sup>



What about crossing oculomotor nerves?

Can see op. fibers crossing over  
op. lobes in L.O. Maybe there fish  
would be better than amphib.  
for test; course of regn.

How about crossing optic nerves?

" " contralateral eye brought?

The goby brain is extremely easy to  
get at / and they don't seem to mind  
much having portions of fore brain +  
midbrain removed.

Got good op. R's in both discs  
after excising major part of one op. lobe.



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Chalk residence  
368 N. E. 57th St.  
Miami, Fla.

Lee's or Fishin' Hole tackle shops at beginning  
of County Causeway for raw cane poles

Odelaide Jordan, Dept of Museum.

Ship things to Lab of Miss Sutton

When returning - have things sent to Customs  
down there & check them in there rather than up  
in Chicago



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Experimental data, planning, notes  
Bimini 1948 Feb-Mar.

- #14
1. Crushed optic nerve
  2. Nerve section & 180° rotation
  3. Eye transplants