Managing Narcosis

Under the influence: A performance guide to managing narcosis
—from aquaCORPS *# 3, DEEP, JAN91*

Text by Barry Fowler, Ph.D.
Illustrations by Andrew Bell
Creaturesinmyhead.com

Breathing hyperbaric air causes a syndrome of behavioral and subjective effects called nitrogen narcosis, which limits the work efficiency of divers and is ultimately life-threatening.

squishy...
i feel squishy

Table 1(right) presents the classic view of the progressive effects of nitrogen narcosis based on descriptions in a number of current textbooks (Bennett, 1981; Miller, 1979; Edmonds et al., 1983). This view emphasizes the growing helplessness of the diver to combat narcosis until eventually stupification sets in at 295 fsw.

The image of helplessness is reinforced by Cousteau's well-known description of narcosis as "raptures of the deep" and his accompanying warnings about a loss of self control, which is exemplified by the urge a diver might have to give his mouthpiece to a passing fish.

Given the assumption of helplessness, it is not surprising that the usual advice to divers is to avoid narcosis by not descending too deep, or to ascend immediately when symptoms are encountered. This is excellent advice: narcosis should be avoided if possible. On the other hand, this advice is not helpful to those divers who must work while narcotic.

The purpose of this paper is twofold. First, to highlight recent advances in behavioral research on narcosis, which suggest that it might be possible to develop training procedures to improve the work effectiveness and safety of divers exposed to narcosis. The second purpose is to propose some principles that could serve as a guide for he development of these procedures. For more detail on the experiments mentioned in this paper, the reader is referred to a recent review covering the last 15 years of behavioral research on narcosis (Fowler, et al., 1985).

Narcosis as a slowing of responding

Recently, a theory called, the slowed processing model, has been proposed, which suggests that, prior to unconsciousness, the primary effect of narcosis on performance arises from a single fundamental deficit in the central nervous system. This deficit is thought to be a decrease in arousal which slows responding but does not cause perceptual distortions of either vision or audition.

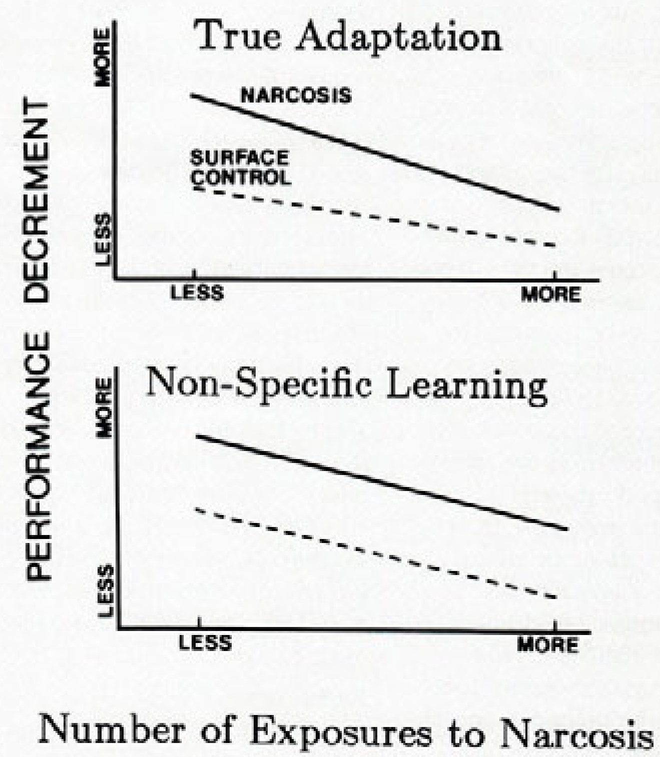


Figure 1 True adaptation to narcosis is illustrated in the top figure and non-specific learning in the bottom one. It is assumed that learning is occuring on the task but adaptation could occur without learning.

Adaptation to narcosis: Number of Exposures to Narcosis, Figure 1. True adaptation to narcosis is illustrated in the top figure and non-specific learning in the bottom one. It is assumed that learning is occurring on the task but adaptation could occur without learning

TABLE 1: A summary of the classic view of the progressive effects of nitrogen narcosis.

4ATA (98 fsw)
Mild euphoria, delayed responses

6ATA (164 fsw)
Sleepiness, hallucinations, impaired judgement; laughter and loquacity may be overcome by self control.

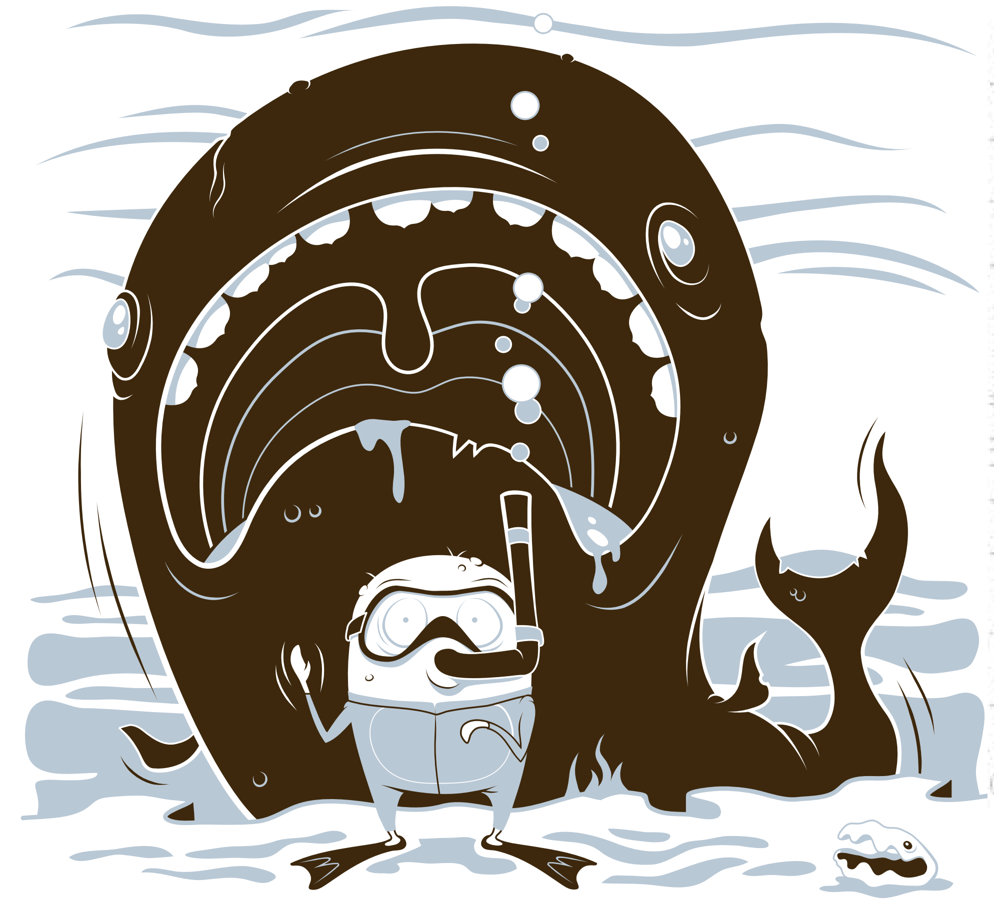
8ATA (230 fsw)
Convivial group atmosphere, severe impairment of intellectual performance, uncontrolled laughter or terror reaction in some.

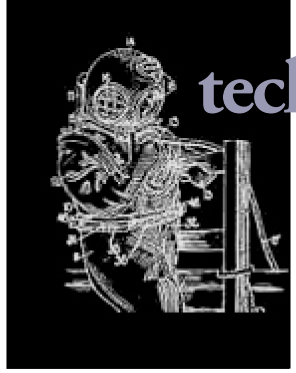
10ATA (299 fsw)
Stupifecation, mental abnormalities, euphoria, almost total loss of intellectual faculties.

The claim that narcosis does not cause perceptual distortions is counterintuitive, because narcosis typically decreases the accuracy of responding as well as increasing response time on a variety of cognitive, perceptual-motor and manual dexterity tasks.

To explain how the slowed processing model accounts for these decreases in accuracy, it is useful to consider an example of the research that is being conducted on narcosis with the hyperbaric facilities at the Defense and Civil Institute of Environmental Medicine in Toronto, Canada. One of the tasks used to study narcosis is called the Serial Choice Reaction Timer. It consists of a set of push buttons arranged so that a finger can rest comfortably on each one.

Adjacent to each button is a light-emitting diode. The task is to extinguish





a lighted diode as quickly as possible by pressing the appropriate button. This lights another diode randomly which must then be extinguished and so on for a specified period of time—usually 90 seconds. A computer controls this sequence of events and also records reaction time and the number of times an unlit button is pressed—this is defined as an error and reflects the level of accuracy.

Subjects performing this task in a hyperbaric chamber at the equivalent of 295 fsw show an increase in reaction time and in the number of errors committed, but they are not stupefied as the classic view would suggest. Moreover, it turns out that these errors can be eliminated by training the subjects to slow down. In other words, the loss in accuracy can be controlled at the expense of speed.

Generally speaking, it appears that this is true for many tasks where a loss of accuracy is not necessarily part of the performance breakdown due to narcosis. To summarize, the slowed processing model holds that decreased accuracy on many tasks is due to untrained individuals working too quickly and being willing to take more risks than usual.

Two training principles are suggested by this research. First, disorganized behavior is not necessarily part of narcosis and can be overcome by training. Second, errors can be avoided by slowing down. Conversely, when time is at a premium and the diver is hurrying, an increase in errors will be unavoidable. The potential costs of these errors in terms of work efficiency and safety must be weighed against the possible gains.

For example, it might be acceptable to hurry and make an assembling a piece of apparatus. It would not be acceptable to hurry and make an incorrect decision resulting in loss of orientation with respect to an anchor or guideline.

FOWLER ON NARCOSIS

- Disorganized behavior is not a necessary part of narcosis and can be overcome by training. Errors can be avoided by slowing down.
- Divers should rely on memory as little as possible. When memory must be relied on, the material should be highly overlearned and memory cues used to minimize forgetting.
- Divers must become familiar and comfortable with the sensations of narcosis, and learn to allocate attention between the task and the symptoms in a manner appropriate to the situation. Divers can learn to use the intensity and type of symptoms to estimate performance capability.
- Divers should practice as much as possible prior to the dive on the tasks to be performed underwater. ■

...i thought i could handle it.

Effects of narcosis on memory

Tasks involving long-term memory and learning are one area where slowed processing model is unsuccessful in explaining decreases in accuracy by a failure to slow down. Narcosis causes forgetting, which can be so severe that it was evident to early observers.

Even before World War II, it was noticed that, after surfacing, divers were unable to recall all the events that had taken place under water. More recently, research has demonstrated another effect. During a dive, Material learned beforehand may not be recalled.

Quite clearly, these forms of amnesia raise a number of potential problems. During the dive, there is the possibility of forgetting previously learned instructions and the learning of new material will be impaired. This latter effect will contribute to difficulty in solving new problems. After surfacing, events during the dive may not be recalled.

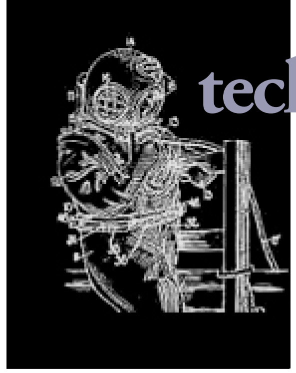
Two training principles could be employed to counter these amnesic effects. First, the diver should rely on memory as little as possible. Second, when memory must be relied on, the material should be highly overlearned and memory cues used to minimize forgetting.

Examples of procedures relating to the first principle include preparing and using a check-off list, which details every stage of the dive and recording all interesting observations during the dive. With respect to the second principle, divers must overlearn any emergency procedure, which is to be executed quickly in a precise sequence. In addition, an obtrusive alarm system should serve as a cue for critical items, such as bottom departure time.

Subjective symptoms of narcosis

—and their relationship to performance

The term “raptures of the deep” was coined to highlight a striking



tech talk

Narcosis

characteristic of narcosis—the subjective sensations of euphoria which may induce rash behavior. However, the point was made earlier that divers can be trained to act rationally under narcosis. One may feel euphoric without necessarily acting these feelings.

The emphasis on euphoria has obscured the fact that there are other subjective sensations induced by narcosis. These have been documented by asking experienced divers to identify adjectives describing their feelings. In all, four clusters of adjectives have been identified. These relate to euphoria (e.g. more carefree and cheerful), consciousness (e.g. more fuzzy and hazy), work capability (e.g. less effective and efficient) and inhibitory state (e.g. less cautious and self-controlled).

this is the last time I do this for you...

For training purposes, it is important to note that, apart from inducing rash behavior, subjective symptoms have the potential to influence performance in two ways. First, performance may be disrupted because the diver pays attention to the internal sensations of narcosis at the expense of maintaining concentrations on the environment and the task.

This is because a fairly strong relationship has been demonstrated between subjective ratings of the severity of narcosis and the degree of performance impairment. It should be noted that this study was performed under ideal conditions in a dry hyperbaric chamber and possibly these results could not be replicated under water. This is because a variety of other factors, e.g. cold, anxiety and fatigue, could all produce sensations which might mask narcosis.

The potential influence of the subjective symptoms of narcosis on performance suggests three training principles. First, the diver must become familiar and comfortable with the sensations of narcosis. Second, the diver must learn to allocate attention between the task and the symptoms of a manner appropriate to the situation.

The object here is to prevent a performance deficit due to inattention, but at the same time, not to ignore the symptoms entirely. The reason for not ignoring symptoms becomes apparent in the third principle. This states that a diver should be taught to use the intensity and type of symptoms to estimate performance capability. For example, in the event of inadvertently exceeding the depth limit during an excursion dive, subjective symptoms could be the first warning if the development of a life-threatening situation.

Adaptation to narcosis

It is generally agreed by divers that frequent exposure to narcosis leads to adaptation. The problem is that research on this question has not clarified what kind of adaptation is taking place (Fowler, et al., 1985).

There is some evidence of adaptation that is specific to narcosis. This means that, over successive exposures, performance under narcosis improves at a greater rate than a surface control—this is true adaptation.

On the other hand, this kind of adaptation has not been found in some experiments where the improvement in performance is identical for narcosis and the surface control. This is a case of non-specific learning, but it is important to note that there is still an improvement in performance under narcosis. Figure 1 illustrates these two cases.

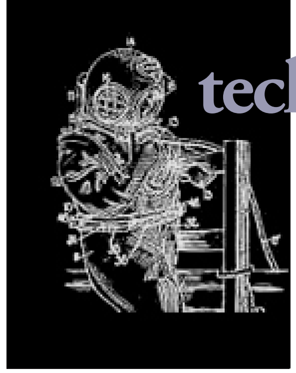
Three conclusions are suggested by these results. First, true adaptation to narcosis may occur but only under certain circumstances which are not presently understood. Second, it is possible that divers may sometimes mistake non-specific learning for true adaptation. Third, it is not clear what the relationship is between the adaptation of subjective symptoms and the adaptation of objective performance. It is possible that divers may be basing their opinions about adaptation largely on subjective symptoms. To date, researchers have ignored this possibility and focused on measuring the adaptation of objective performance.

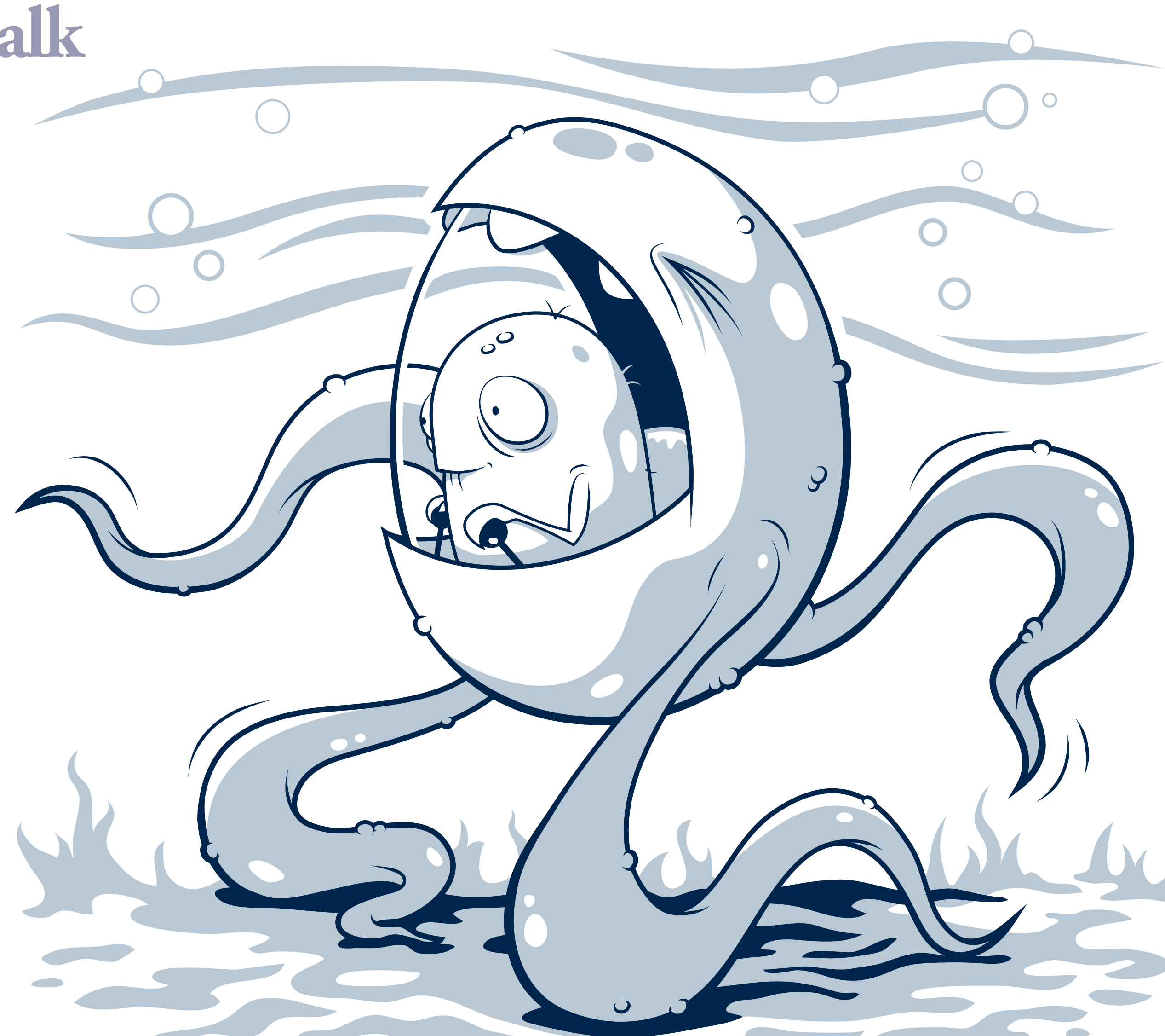
It is clear that a good deal more research is required before the issues raised here about adaptation are resolved. In the absence of clear-cut research results, it is difficult to offer specific training principles which take advantage of adaptation or non-specific learning.

Until these results become available, a generally useful training principle is to provide the diver with as much practice as possible prior to the dive on the tasks to be performed under water. If these tasks can be practiced under narcosis prior to the dive, so much the better. There are some techniques that might be useful for this purpose, but it is beyond the scope of this paper to discuss them.

Some final caveats

The eight training principles that have been proposed are aimed at controlling and possibly ameliorating the effects of narcosis





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when it cannot be avoided. Underlying these principles is a view of narcosis, expressed in terms of the slowed processing model, which differs from that presented in current textbooks. However, it must be emphasized that these principles are only tentative and must be tested by controlled research. There is definitely no suggestion that current maximum depth guidelines for sports divers should be violated.

Finally, for the purposes of this paper, the whole question of predicting performance in the underwater environment has been over-simplified. There are a variety of other stressors, which coexist with narcosis and which, in combination with it, have the potential to place severe limits on performance.

These include hypercapnia, cold, anxiety, perceptual disorders and weightlessness (Fowler, et al. 1983; Godden and Baddeley, 1979). This has been demonstrated clearly in the case of anxiety (Baddeley and Fleming, 1967), but information about other combinations is virtually non-existant. If deep diving on air is to be carried out with a maximum of safety and efficiency, training procedures must not only be guided by the effects of narcosis on performance, but also by the effects of any additional stressor that may be present in combination with narcosis.

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The Insidious Threat of Hypoxic Blackout in Rebreather Diving

Why rebreather divers, even more so than open circuit divers, need to be in control and focused when they ascend.

Text by Simon Pridmore

Rebreathers allow divers to enter a realm of undreamed-of opportunity. However, while they provide a solution to many of the drawbacks of open circuit scuba diving, such as limited gas supply, noise and short no–decompression limits, rebreathers also expose divers to a number of new concerns, which is why proper training and lots of practice in emergency procedures are essential.

Not only free divers

One of these concerns is a widely misunderstood phenomenon most frequently referred to as shallow water or hypoxic blackout, something that hitherto has typically been a problem encountered mainly by free divers.

A technique many free divers practice to extend their time underwater is hyperventilation. They breathe in and out aggressively to reduce their carbon dioxide levels as much as possible. This causes the breathing reflex and onset of anxiety to be delayed while they are underwater. Then they dive. As they swim their bodies metabolize the oxygen and convert it into carbon dioxide and the longer they are down the more oxygen is metabolized.

It may well be this phenomenon lies behind a number of unexplained rebreather fatalities in recent years.

Maintaining conciousness

Human beings can function normally at oxygen partial pressures of between 0.16 and 0.5. At partial pressures greater than 0.5 we are at risk from oxygen toxicity: at partial pressures below 0.16 the oxygen level is insufficient for us to maintain consciousness.

At the surface, the oxygen partial pressure in the air the free diver breathes is 0.21. When he arrives at 10m (33ft), generally speaking, the percentage of oxygen in the air in his lungs is still 21 percent, but as he is now at an ambient pressure of two atmospheres and as the pressure of the air in his lungs has now doubled, the partial pressure of the oxygen in his lungs is 0.42.

Dropping pO_2

This partial pressure then starts to drop and continues to fall as the oxygen is metabolized. If the diver stays at depth until the partial pressure drops to 0.28, he is fine, but this equates to a partial pressure of only 0.14 at the surface. So, as he ascends and his oxygen partial pressure drops with the reduction in ambient pressure, somewhere at a point close to the surface it will fall below 0.16, the diver will black out abruptly and, if he is not positively buoyant, will sink back down to the depths.

Rebreather divers can encounter similar issues as they ascend. On most electronic CCRs, the oxygen level in the diver's breathing supply is maintained at a preset level. As the diver ascends, the ambient pressure drops as does the partial pressure of oxygen in the diver's breathing loop.

Lag effect

When the rebreather's electronics detect that this is happening they direct a solenoid to allow a fresh injection of oxygen into the loop to maintain the partial pressure at the desired level. If the diver's ascent is too rapid, however, the electronics may not have time to pick up and compensate for the oxygen shortfall. Furthermore, if the oxygen cylinder is empty or if corrosion or other debris is blocking the injector then no oxygen can be added, no matter how controlled the ascent. If the diver does not monitor his oxygen partial pressure and act to manually sustain a breathable oxygen level by, for instance manually injecting fresh diluent gas into his breathing loop, he will black out before he reaches the surface.

One of these concerns is a widely misunderstood phenomenon most frequently referred to as shallow water or hypoxic blackout, something that hitherto has typically been a problem encountered mainly by free divers.

There are no warning signs or symptoms

It may well be that this phenomenon lies behind a number of unexplained rebreather fatalities in recent years. With very few exceptions, we all begin our diving lives on open circuit scuba and acquire open circuit habits. It is common in standard no decompression sport diving for divers to relax their vigilance once they begin their ascent. The dive is over and their attention starts to wander. It is also natural for a diver who encounters a problem or feels uncomfortable to quickly seek sanctuary in the shallows. After all, this makes good sense in open circuit terms because the shallower you are, the less air you use and the more time you have to solve any problem.

Resist the tendency

Due to the dangers of hypoxic blackout rebreather divers have to be trained to resist such tendencies, and it can require intensive practice for them to achieve the instinctive level of concentration and discipline required. The ability to conduct a controlled and considered ascent is a widely underestimated tool in any diver's skill set. For a rebreather diver, it is an essential survival technique. ■

Simon Pridmore is the author of Scuba Confidential: An Insider's Guide to Becoming a Better Diver, *which will be available from Best Publishing Company in late 2011. See www.scubaconfidential.com for an advance preview.*

Subject: Clown Anemonefish (*Amphiprion ocellatus*), Lembeh Straits, Indonesia. 105mm lens, ISO 200, Sea & Sea YS110 flash, 1/125th second at F22

Flash Photography

Text and photos by Lawson Wood

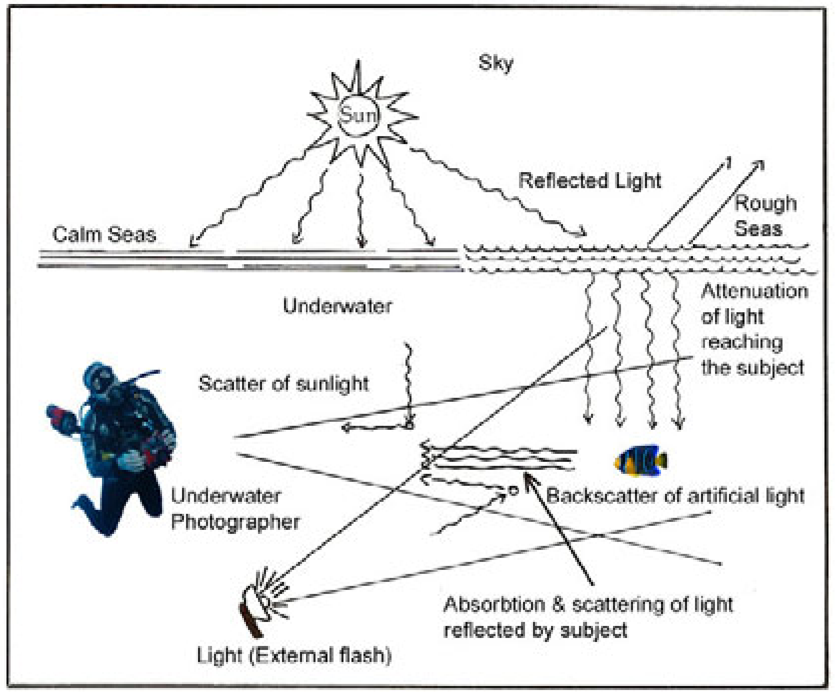
We already know that as you go underwater light refracts and changes colour with the density of the water. You lose the colour red in less than two metres (6.5ft) and that colour gradually loses intensity the deeper we go underwater. To compensate for this loss of light and colour, we either add a flash to illuminate the subject, a filter to alter the colour spectrum being 'seen' by the camera, change the white balance accordingly at the beginning of the dive or by a quick fix on Photoshop. This loss of colour is the underwater photographer's ultimate challenge; our goal is to bring back as much of the real and natural colour as possible, allowing the viewer to truly appreciate the splendour of our underwater world.

By far, the simplest (yet costly) way forward is to use flash. Most compact cameras have fairly adequate internal flash to illuminate close-up subjects, but this small flash is not strong enough to illuminate larger subjects or subjects at a distance of over 1metre (3.25ft). Those compact camera owners are recommended to purchase an additional external flash unit that actually fires as a 'slave' to the camera's own internal flash by the use of a fibre optic cable, allowing for a greater spread of light to illuminate a larger subject area. White balance settings ultimately always help, but the addition of external flash is better still.

Light underwater—*The way light is affected once we go underwater*

As you can see, light and its absorption causes all sorts of problems once it starts to penetrate the underwater realm.

The principal problem which underwater photographers face is the fact that *we are underwater,* and it is the water that gets in the way of the picture, or more accurately, it is the particles in suspension in the water, (which reduces the visibility) which get in the way of a clearly lit photograph. In low visibility, these particulate—be they planktonic debris, bits of rusty particles knocked off an old wreck, small marine critters dislodged by a diver's exhaust air bubbles, the bubbles themselves or sedimentation—any and all of the above can and normally will produce an effect called 'backscatter'. This occurs when the burst of light produced by your electronic flash bounces off and reflects back to the camera's lens before it has reached the subject to be illuminated.



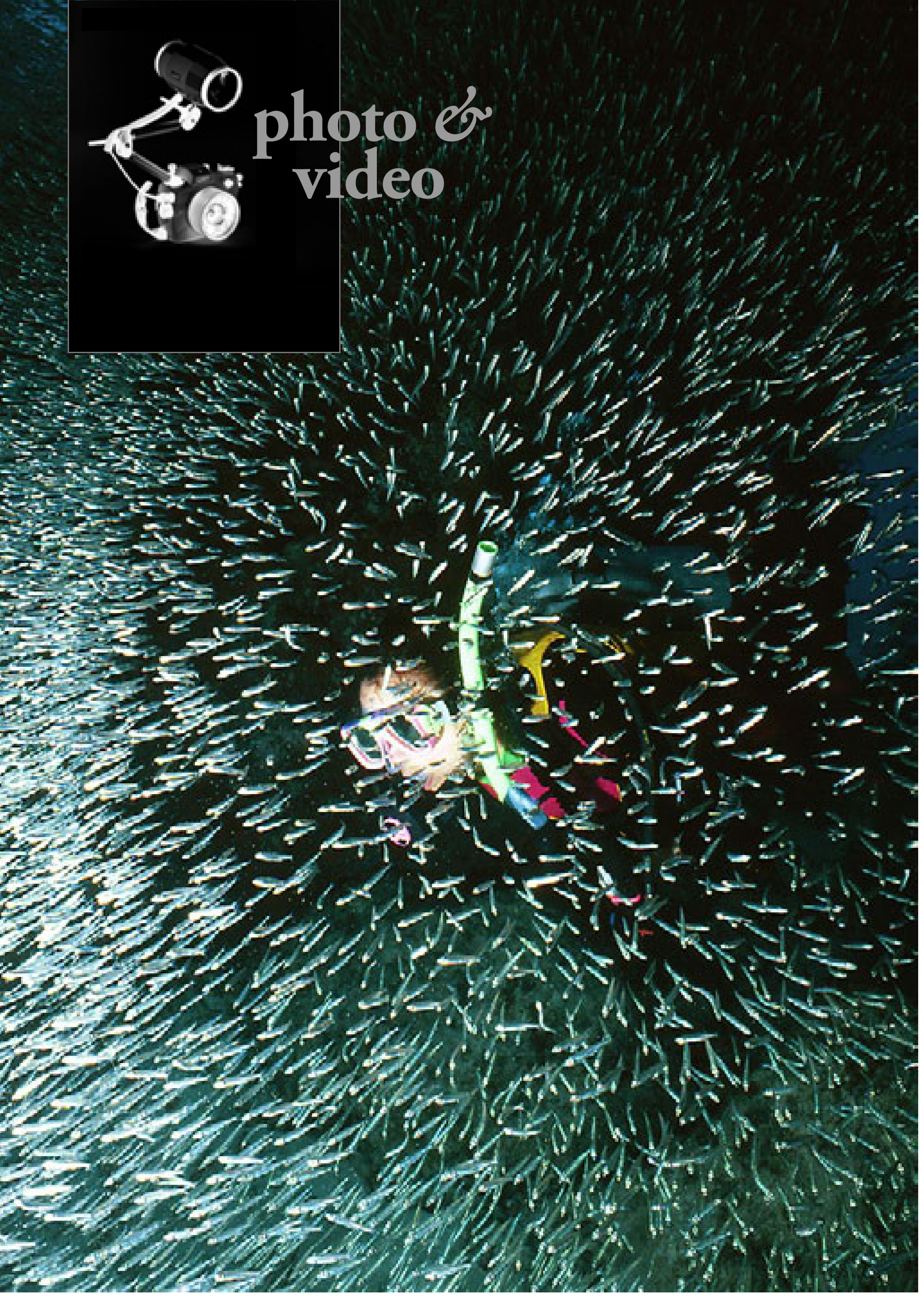
When using flash to take a photograph of the subject, not only do we have to cope with the attenuation of light reaching the subject, we also have to deal with various sea conditions: sunny or cloudy overcast days, highly reflective subjects such as silverside minnows or even a diver's bald head!

(Assuming that the water is crystal clear) the calmer the water the more light is able to penetrate into the depths and allow for natural light illumination of your subject. This obviously does not happen in poor visibility areas, and these dives should almost be treated as potential night dives.

The rougher the water, the more a higher percentage of the sun's rays are deflected back up into the atmosphere. Light does filter down from above to the subject, but due to the refractive index of light absorption, you lose the colour red in approximately 2m (6.5ft) of water. There is of course a scattering of light in the water column as well as the subject matter actually absorbing and reflecting light particles as you take the photograph. A white sandy seabed will help the overall illumination, but black sand will absorb the light.

Reflective surfaces such as the sides of these silverside minnows have to be treated with caution, as too much flash will produce flare that will bounce back and overexpose the photograph.

By concentrating the flash directly



Subject: Kelly and school of Silverside Minnows, Little Cayman Island. 15mm lens, Fuji Velvia (scanned), ISO 50, Sea & Sea YS200 flash, 1/125th second at F16

Subject: Stareye Hermit Crab (*Dardanus venosus*), Dominica. Canon Powershot S95, Auto settings

into the centre of the subject area, I was able to illuminate all of the fish, and the extreme wide angle of the lens gave the impression of vignetting with the outside of the frame fading to dark. Undoubtedly, flash always enhances a highly colourful subject, but it is also extremely effective in illuminating fairly monochrome subjects such as the silvery fish.

On a compact camera, the use of the camera's internal flash (whilst it is powerful enough to illuminate the subject) it is incorrectly positioned due to the housing's manufacture, and this will always create a shadow in the lower right hand side of the photograph, particularly when using the macro setting on the camera.

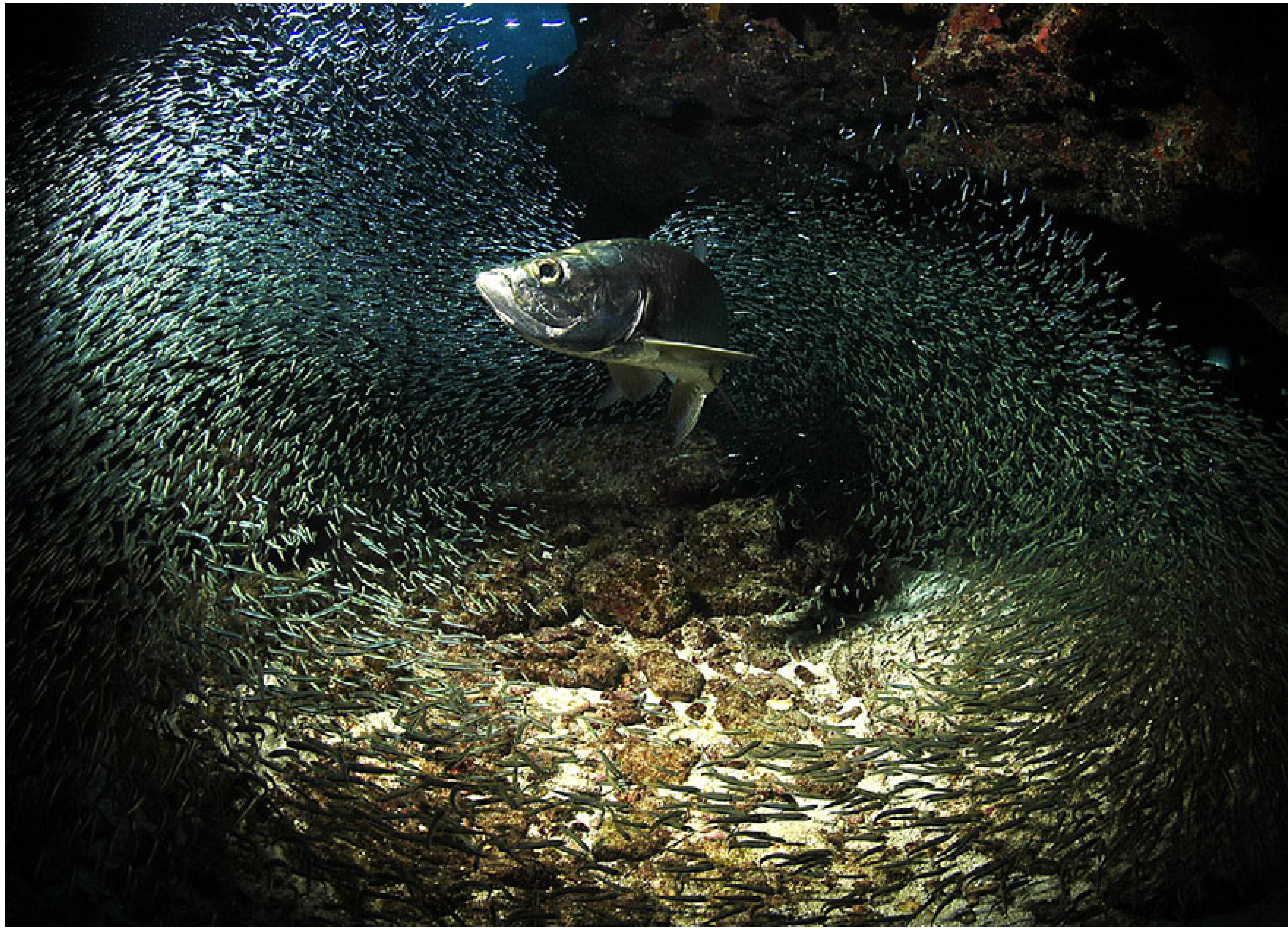
The way to get around this anomaly is to keep the camera setting on macro, with the flash on, move further back and away from the subject (this also eases the stress on you and the critter) and use the camera's internal zoom lens to get closer once more and allow you to compose the subject with full illumination, no stress and no shadows.

As you can see, clearly illustrated in the images (top right) is the problem with the Canon compact camera's housing creating a shadow when working in close to the subject, yet it is cured by staying further back and using the zoom instead.

The use of 'fill-in' flash is perhaps the most rewarding as our camera's automatic settings do like to give their sensor's rendition of the colour of the background water, whether it be the green of Scottish waters or the brilliant cobalt blue of the Red Sea, Pacific or Caribbean waters. By using just enough flash to 'fill in' the colours of the subject in the foreground, yet still take the photograph at the same aperture (of the natural light available), we are able to give colour and depth to the subject and the scene overall.

Challenges

The use of flash underwater in inevitably challenging. Take for instance the two wreck photographs (next page) taken recently at Scapa Flow in the Orkney Islands off the northern shores of Scotland. Both are in very similar con-



Subject: Tarpon and school of Silverside Minnows, East End, Grand Cayman Island
10.5mm lens, ISO 100, Twin Sea & Sea YS100 flash, 1.80th second at F8

Subject: Technical Diver Nat from Divetech on Grand Cayman Island. 10.5mm lens, ISO 100, Twin Sea & Sea YS110 flash, 1/80h second at F:11

Subject: Stern gun on the German Batlecruiser *Kronprinz Wilhelm*, Scapa Flow, Scotland. 10.5mm lens, ISO 400, Twin Sea & Sea YS110 flash, 1/80h second at F:5.6

Subject: Stern gun on the German Light Cruiser *Karlsruhe*, Scapa Flow, Scotland. 10.5mm lens, ISO 200, Twin Sea & Sea YS110 flash, 1/80h second at F:5.6

ditions, but the first photograph on the *Kronprinz Wilhelm* is taken in 46m (150ft), and we are actually underneath the ship. The muddy seabed is getting stirred up; there is no natural light due to the deep shadow created by the looming shipwreck overhead, and I have to completely illuminate all of the subject area. The second photograph on the *Karlsruhe* is taken in 26m (90ft). The underwater visibility is the same, but there is now enough ambient light to illuminate the subject area, but I still need 'fill-in' flash to highlight the divers and the wreckage of the gun in the foreground. The divers/models are using their dive lights and these also give the impression that it is the divers who are illuminating the gun, and not my camera's flash—pretty near perfect, as far as I am concerned!

Problems to avoid

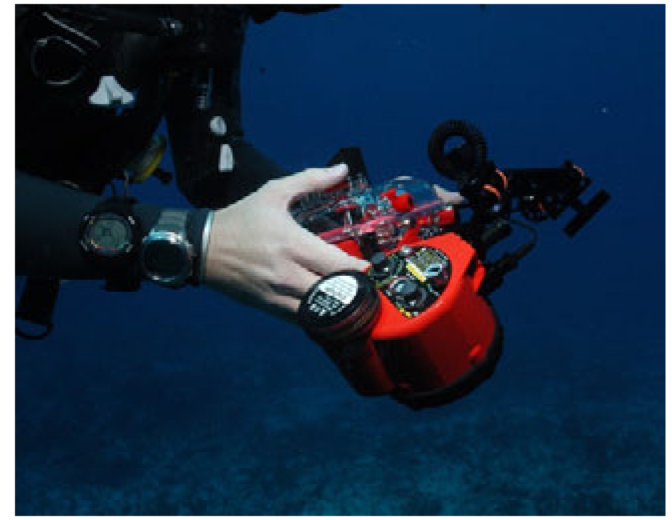
By not taking care in the use of the camera's command dial (image next page), I reversed the settings that I was aiming for and subsequently lowered the aperture and increased the speed of the shutter. Sadly, my flash did not synchronize to the 1000th of a second shutter speed and failed to fully illuminate the subject. Care must always be taken when adjusting the camera speed and shutter control. Try not to be in a rush as obvious mistakes like this one should be easily avoided and photographers of my experience should no better!

A similar problem, but at the opposite end of the spectrum happens when the camera is set on automatic and trusting that the flash will recharge in time to be able to synchronize with the shutter speed. Sadly, the flash has not recharged in time to be able to fire,

Subject: Banded Shrimpgoby (*Neoturris pileata*), Red Sea. 60mm lens, ISO 100, Sea & Sea YS180 flash, 1/1000th second at F3.4

Subject: Green Turtle (*Chelonia mydas*) Sipadan Island, Malaysia. 20mm lens, ISO 100, Sea & Sea (misfired) YS180 flash, 1/8th second at F3.4

Flash



A Compact Camera with attached external flash

and the automatic setting on the camera has reduced the shutter speed so low that the subject is not only moving, it is out of focus too. (Nevertheless, it is still a pleasing photograph!)

The sequence of two photographs (bottom right) that I am using to illustrate this example were actually taken with the flash (full colour) photograph on the right first, followed instantaneously by the second photograph before the flash had time to recycle and fire again. The subjects are virtually identical, excepting that one can clearly see the effects of using or not using flash underwater to illuminate a subject area. The flash has clearly illuminated the brilliant colours of the soft corals, yet have failed in power to reach my dive partner, Reeta, in the background, exactly the effect that I was wanting to achieve. By reversing these images in a dissolve style audio-visual presentation, you have the effect of a rather drab colourless photograph virtually coming to light before your eyes.

Undoubtedly, the use of flash underwater is absolutely essential to bring to light (please excuse the pun) the actual true and brilliant colours which the eye and the camera lens rarely see in all of their glory, except in extremely shallow water. Only with flash, set to the correct colour temperature as that of daylight (approximately 6,500K) that you are able to obtain truly stunning colour renditions of a rather drab and usually colourless underwater world.

Flash photography, of course, is always used on night dives, as rarely do divers carry sufficient continuous and powerful lights to completely illuminate the seabed to allow your camera to use a natural light setting, even at night. Sorry, but I have actually witnessed this! For the rest of us, the use of a camera and flash either internal or external on a compact camera and externally on a housed Dslr are dérigueur for all of us underwater photographers.

The use of a spotting light (often located inside the flash) such as some of the Sea & Sea flash, Ikelite

Subject: Reeta Tunney along a wall of soft corals in the northern Red Sea. 10.5mm lens, ISO 100, Twin Sea & Sea YS110 flash, 1/125th second at 8.

photo & video

and Inon models is an absolute must not only to aid composition, but for also finding immediately which brilliant colours are on display by many of the marine critters that are often only seen out at night.

No matter what type of camera you are carrying underwater, buoyancy control has to be second nature in approaching your subject matter.

No matter what type of underwater camera system you opt for, immediately you will note the distinct difference in size. They say size doesn't matter—well apparently it does! With more and more weight restrictions being levied on international airline travelers, the underwater photographer undoubtedly feels the brunt of these rules as invariably there will be additional costs levied onto your holiday travel cost.

With this in mind, many divers opt for the simpler (yet still very versatile) compact camera, or ICL, as it can be carried in hand luggage and rarely raises an eyebrow as it passes through X-ray machines. For those of us lumbered with large Dslr's, plus housing; plus perhaps two external flash; extendable arms; batteries; recharging units; numerous lenses; numerous ports for the housing to suit the lenses and inevitably we will also be trying to smuggle on board a laptop computer; external hard drives; memory cards and even DVD's. Can you imagine the apoplexy that the security guards have at airports when they see all that hardware in one case that can hardly be called hand baggage, as it weighs more than your hold luggage with all of your diving gear; torch lights; diving computer; clothes and wee home from home snacks to make your overseas dive trip more bearable, just in case you do not like the food!

Who on Earth said that this was fun! But, when those little critters start to perform for you, or when that whaleshark just arrives at the same time as you, or when you find your first hairy squat lobster without the use of a dive guide, and you correctly illuminate a golden cup coral on a night dive, then all the effort is worth it.

As we have discussed,

Subject: Golden Cup Coral (*Tubastrea aurea*) northern Red Sea. 105mm lens with +2 dioptre, ISO 100, Twin Sea & Sea YS110 flash, 1/80h second at F:8

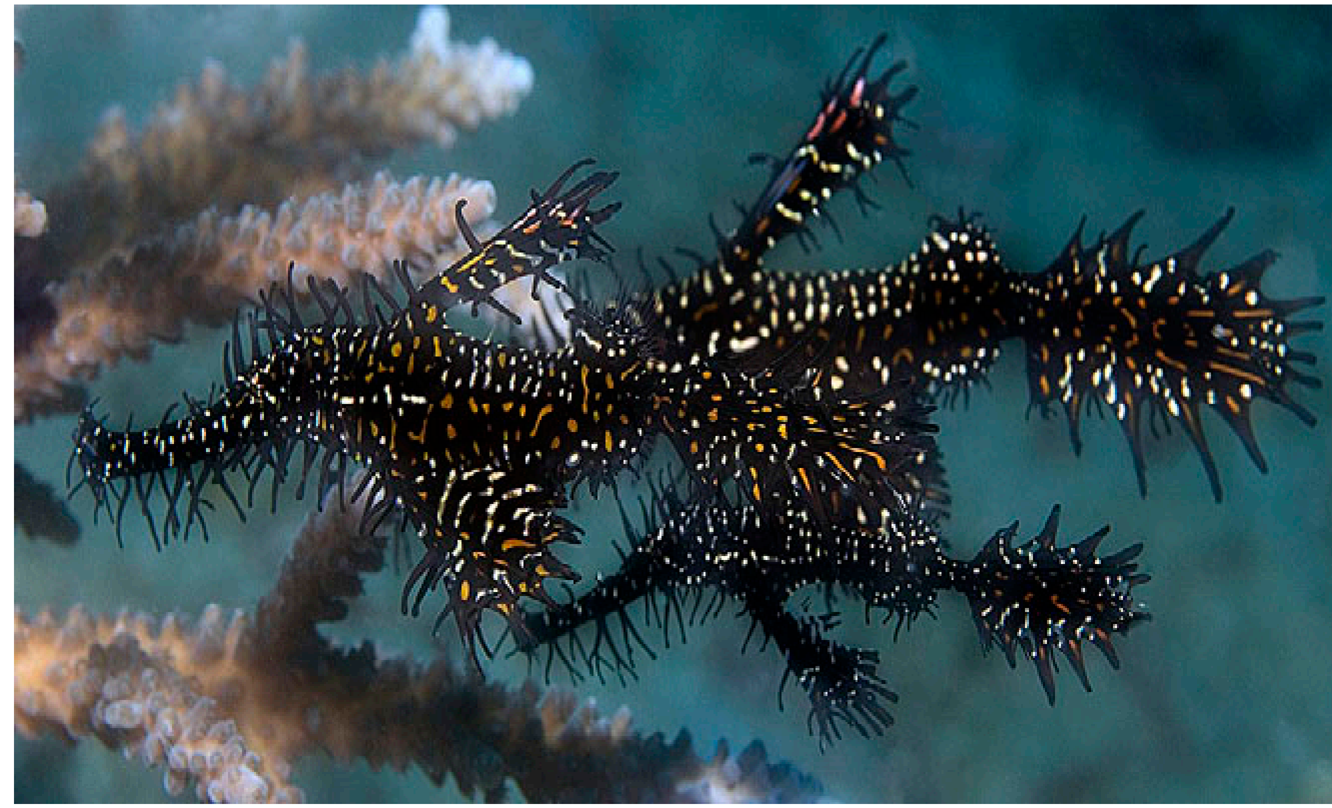
Subject: Snowy, Jackson Reef, northern Red Sea, 10.5mm lens, ISO 100, twin Sea & Sea YS110 flash, 1/125th second at F8

Subject: Salmon (*Salmo salar*), Deep Sea World Aquarium, North Queensferry, Scotland,15mm lens, Fuji Velvia (scanned), ISO 50, Sea & Sea YS120 flash, 1/125th second at F:11

Subject: Dahlia Anemone (*Urticina eques*) St.Abbs, Scotland.15mm lens, Fuji Velvia (scanned), ISO 50, Sea & Sea YS200 flash, 1/60th second at F16

Subject: Ornate Ghost Pipefish (*Solenostomus paradoxus*) Gangga sland, North Sulawesi, Indonesia. 60mm lens, ISO 100, Sea & Sea YS120 flash, 1/125th second at F:11

Subject: Ornate Ghost Pipefish (*Solenostomus paradoxus*) Gangga sland, North Sulawesi, Indonesia. 60mm lens, ISO 100, Sea & Sea YS120 flash, 1/125th second at F:11



the main problem that underwater photographers have is the fact that the water gets in the way of the picture, or more accurately, it is the particles in suspension in the water, which get in the way of a clearly lit photograph. In low visibility, these particles in suspension, be they planktonic debris or sedimentation, will produce an effect called 'back-scatter'. This occurs when the burst of light produced by your electronic flash bounces off and reflects back to the camera's lens, before it has reached the subject to be illuminated.

To counteract this effect, there is a combination of steps that you can take:

1. Get as close to your subject as possible; in effect, remove the water element by using a wide angle lens.
2. Hand hold or repostion the flash to cut across the sedimentation and so limit the backscatter.
3. Only use a flash to subject distance of one fifth of the underwater visibility. (ie. if the viz' is only 5m, the maximum distance your flash to subject distance should be only 1m)
4. Better still, only take photographs in clear, clean warm water.

Sometimes backscatter can be used to your advantage. Undoubtedly, some of these photographs illustrated work because of the backscatter. It gives a very real sense of being underwater and highlights the fact that not all of our diving is in crystal clear water in exotic locations. Most of us dive much closer to home, and invariably, our home waters are generally not as clear as we would like them to be. With the Salmon (previous page), we are faced with lots of highly reflective air bubbles from the underside of a waterfall plunging into a fresh water pool, and the other is quite simply taken in extremely bad visibility where backscatter is expected—it is accepted, and it is then used to create the photograph required.

Sometimes however, no matter how skillful you are in underwater photography and Photoshop techniques, some photographs are just not worth rescuing. In this instance (top image), not only am I too close to the subjects, the visibility is just too poor; I have got my lighting wrong, and generally, this should be consigned to the digital bin. Such a shame because I just love Ornate Ghost Pipefish.

This is what happens when you get it right (above) with the same subject, same time, just differing compensation for the flash and ambient light and its effect on backscatter.

Buying a flash is easy. Choosing the correct flash for your photography is more difficult, and I suggest that you consult any of the larger retailers such as Ocean Optics, Cameras Underwater or Ocean Leisure Underwater Cameras who will give you independent and informed advice on a large number of flash from different manufacturers. ■

photo & video

News edited by Don Silcock

Nikon mirrorless “1 System”

Nikon has announced the release of the 1 system EVIL camera range. Two new cameras, the J1 and V1, four new lenses and a speedlight make a new range within the Nikon family. Specifications on the new camera include a CX-format, 10.1 megapixel High-Speed AF CMOS, ISO range from 100-3200, a new EXPEED 3 image processing engine and HD movies at 1080p with frame rate control (30, 60, 400 and 1200fps). The new autofocus system in the cameras has 73 focus points and is claimed to be the world’s fastest. The J1 is being aimed at a more general consumer who “who use a camera as part of their connected lifestyle”. The V1 has a magnesium alloy body, mechanical shutter and an enhanced EVF screen. The new lenses announced today include a 10-30mm f3.5-5.6 zoom, a 10mm f2.8 pancake, a 20-110mm f3.8 zoom and a power zoom; the 10-100mm f4.5. The new products will be available from 20 October. The J1 will retail at US$649.95 with the 10-30mm, the V1 at $899.95 with the same lens.
www.nikonusa.com

Canon EOS 1D X

Canon has announced the release of the new EOS 1D X professional camera body. The new camera will replace the EOS-1Ds Mark III and EOS-1D Mark IV in the Canon range and features a new 18 megapixel full frame CMOS sensor, dual LOGIK 5+ image processors, 14 bit data conversion and a frame rate of 12 fps continuous shooting. The new sensor gives an ISO range up to 51,200, with up to 204,800 available in H2 mode, a new 61 point AF within six AF point selection modes, together with a new “intelligent tracking and recognition” option and an exclusive DIGIC 4 processor for metering. The camera features two new HD video formats and 1080 video at 24p (23.976), 25p, or 30p (29.97).
usa.canon.com

Subal housings for Panasonic GF2 and GF2 EVIL cameras

Subal has announced the release of two new housings for the Panasonic GF2 and GF2 EVIL cameras. Both housings feature the standard Subal manufacture techniques and surface coatings, as well as the QuickLock closure system. The SGF2 and SGF3 also feature access to all camera controls (including flash raise/lower), are backwards compatible with all bayonet fitting Subal ports and have a fiber optic port for strobe triggering. **Subal.com**

Watershot video lights

Watershot has announced new and upgraded STRYKR LED lighting products. The new models feature dive and video lights heads that range from 900 to 3000 Lumens. The STRYKR video light heads now come in three varieties: 900, 1800 and 3000 Lumen. They use a separate battery pack, and Watershot offers a variety of these packs allowing the option of one or two light heads to be powered per battery pack. **www.watershot.com**

Amphibico new Genesis video housing

Canadian company Amphibico have announced the release of their Genesis line of compact Prosumer HD housings. The initial release is for the Sony FS100U HXCAM HD camcorder. The new housing is machined from aluminum, and features full access to camcorder controls, a top mounted 3.5” window to view the camera’s LCD, a bayonet lens port mounting system that accepts existing Aquatica ports and an option to mount an Atomos Ninja HD recorder using an optional accessory. **www.amphibico.com**

B17 Black Jack Wreck

Black Jack's tail-plane and Archie the divemaster from Tufi Dive

Text and photos by Don Silcock
www.indopacificimages.com

Lying undisturbed in the deep water just off the fringing reef from the remote village of Boga Boga on the tip of Cape Vogel, is what many consider to be the best aircraft wreck in Papua New Guinea and possibly the world.

The wreck is the B-17F "Black Jack", serial number 41-24521, and one of the first Flying Fortress bombers built at the Boeing factory in Seattle during WWII.

History

The completed plane was delivered to the U.S. Army in July 1942 at a cost of US$314,109 and subsequently flown to Australia, from where it joined the war in the Pacific in early September with the 43rd Bombardment Group, 63rd Bombardment Squadron in Port Moresby.

The plane was assigned to Captain Kenneth McCullar and his crew of nine, and served with distinction over the next few months. It was McCullar, an avid gambler, who gave Black Jack its moniker from the last two digits of its serial number—a jack and an ace is a "blackjack hand" of 21 in the card game of Pontoon.

Captain McCullar was quite a pilot and one who was highly regarded and decorated for his bravery, but who was unfortunately killed in April 1943 when another B17 he was commanding crashed during take-off from Port Moresby. In his obituary, the commander of the 5th U.S. Air Force commented on McCullar's bravery and leadership skills and said "he was a master at the art of sinking Japanese ships".

It was McCullar at the controls of Black Jack that developed the potentially dangerous, but devastating technique of "skip bombing" that is credited in his sinking of the Japanese Kagero Class destroyer Hayashio on the night of the 24th November 1942, in the Huon Gulf.

That attack left Black Jack so badly damaged that it was out of action for two months and when it returned to service it was under the control of McCullar's co-pilot, Lt. Harry Staley who had took over from McCullar when he was promoted to Squadron Commander in January 1943.

Black Jack performed equally well under Staley until he completed his tour of duty and handed the plane over to it's next, and final, pilot—Lt. Ralph De Loach.

The Final Flight

Black Jack's final flight was on 10 July 1943 when it left 7-Mile Airdrome in Port Moresby just before midnight on a mission to bomb the heavily fortified Japanese airfields at Rabaul in

Black Jack sits proudly on the sandy bottom at 50m

New Britain.

The plane's course took it southeast down the coast before it turned northeast over the Owen Stanley Range and Dyke Ackland Bay to the Solomon Sea and on to New Britain. On reaching Kimbe Bay on the north coast, it changed course again and headed east to Rabaul.

The flight was a troubled one, with both right wing engines developing problems during the flight to New Britain. However, De Loach, together with his crew of nine, managed to reach Rabaul and successfully deliver their bombs on target.

De Loach turned the plane round to return to Port Moresby, but on the way back ran into a violent storm on approach to the coast of New Guinea to the northwest of Cape Nelson, a situation he later described the situation as "the blackest of black nights...the worst flying weather I'd ever seen in my life".

With two engines badly malfunctioning, it was impossible to hold the plane on course for Port Moresby and cross the Owen Stanley's, and so Black Jack was turned southeast down the coast towards Milne Bay. They made it as far as Cape Vogel where, with virtually no fuel left, the decision was taken to ditch the plane on the shallow reef that runs parallel to the white sand beach at Boga Boga.

Never having ditched a bomber before, De Loach handed the controls over to his co-pilot, Joseph Moore, who managed to put the plane down but over-shot the reef flat. It ended up over the deep water, where the plane floated briefly before sinking down to the sandy sea bed some 50m below.

There was just enough time for the ten man crew, three of whom had been injured in the landing, to get out before Black Jack sank, and they managed to get to shore with the aid of local villagers who had seen the plane come down.

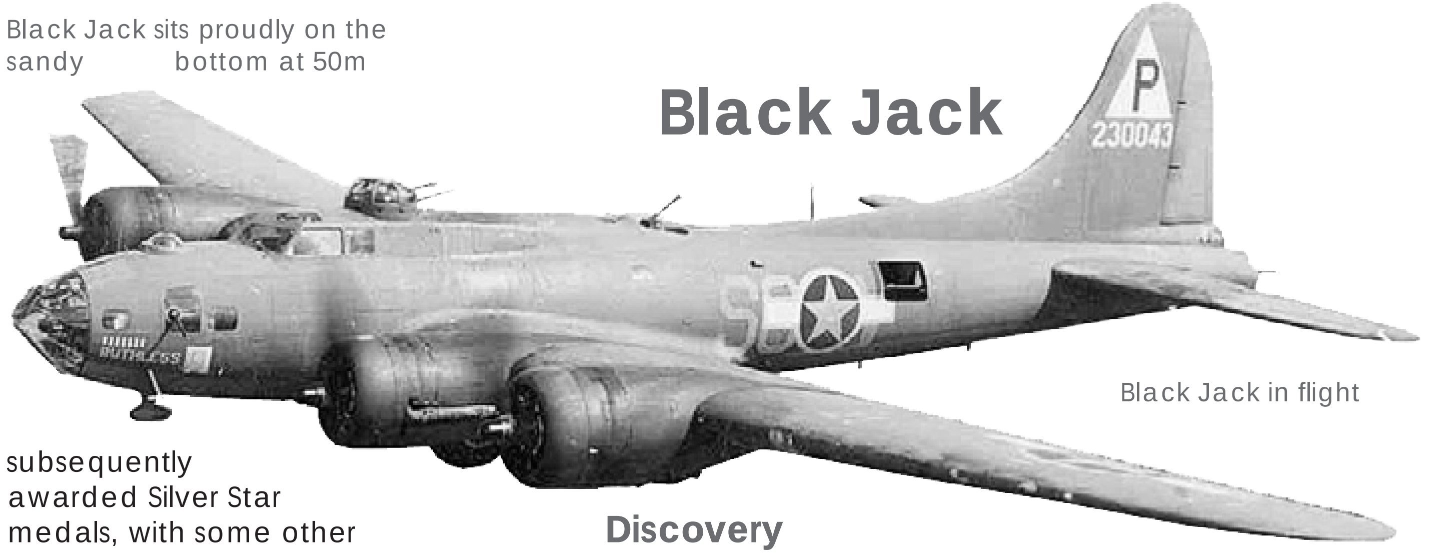
An Australian Coastwatcher named Eric Foster also saw the crash landing and informed air-sea rescue to dispatch an RAAF seaplane to evacuate the wounded. The rest of the crew were rescued two days later when a PT boat arrived to take them to Goodenough Island, where they were flown back to Port Moresby, and then given two weeks leave in Sydney before returning to full combat duty.

The pilot De Loach, and co-pilot Moore were subsequently awarded Silver Star medals, with some other members of the crew receiving the Bronze Star or Oak Leaf Cluster for their parts in the overall mission and getting the plane down.

Black Jack on the other hand lay largely forgotten on the sea floor and remained undisturbed there for another 43 years.

The nose and front of Black Jack shows the full force of the plane's ditching in the sea

Black Jack

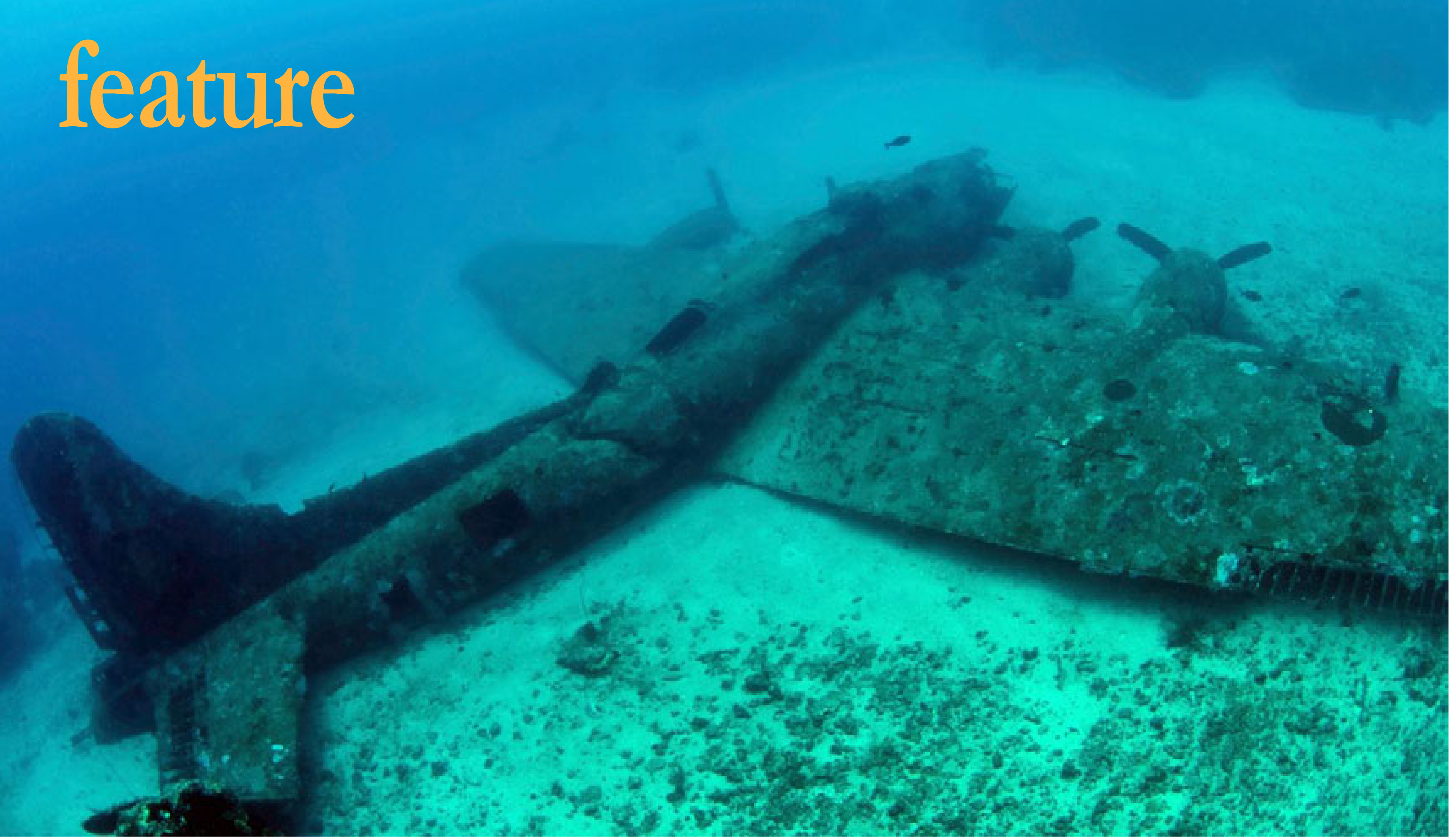


Black Jack in flight

Discovery

The discovery of Black Jack reads like something out of an adventure novel, with three Australians—Rod Pierce, Bruce Johnson and David Pennefather—stumbling on the wreck almost by accident in late December 1986.

Pennefather, an ex-Kiap who spent most of his adult life in PNG and developed a strong interest in WWII wrecks, had visited the Cape Vogel area earlier in 1986 where he heard from the villagers of Bogo Boga that a plane had crashed near their reef in WWII. He subsequently organized a Christmas dive trip with Rod Pierce and Bruce Johnson to try and find what they



believed to be was an Australian Beaufort A9.

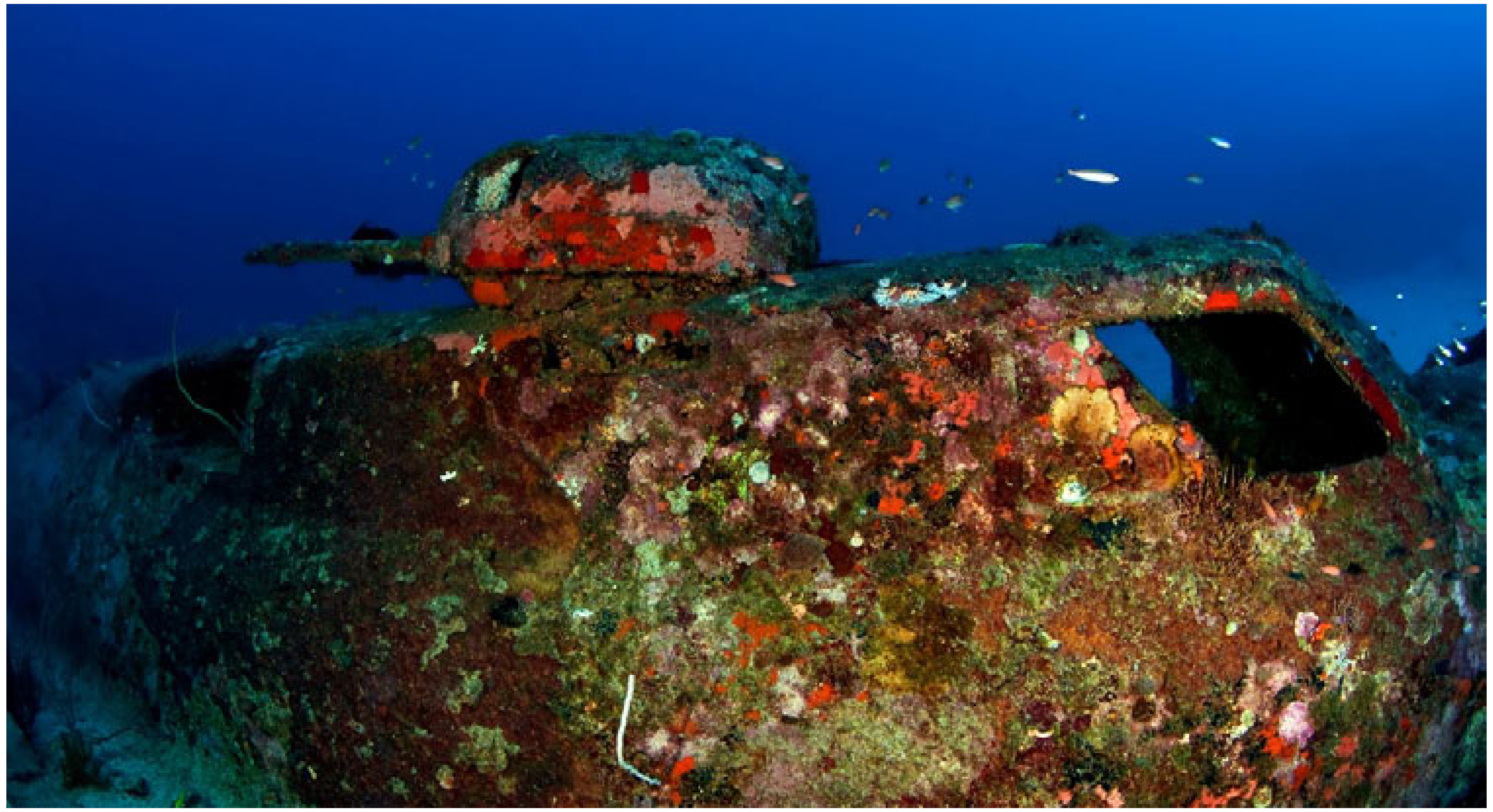
Rod Pierce is the owner of the *MV Barbarian*, a small liveaboard dive boat that is synonymous with wreck diving in Papua New Guinea, and Bruce Johnson was a commercial pilot.

The villagers of Boga Boga guided the three divers to the general location where the plane had gone down, and when they entered the water, the game plan was to spread out and cover as much area as possible to try and find it.

It was Rod Pearce who found the wreck first, spotting the large tail-plane as he conducted his search. One can only imagine the sheer exhilaration he must have felt when he first saw the B17 Flying Fortress sitting there on the sand in almost perfect condition!

For someone who has dedicated his life to wreck diving, it must have been like finding the Holy Grail.

Over the next few days, they dived the wreck as much as its depth of nearly 50m would allow, entering the inside of the plane and finding the Radio Call Plate with the 24521 serial number on it, which later allowed them to positively identify it as the famous Black Jack.



CLOCKWISE FROM TOP LEFT: Black Jack is remarkably intact sitting in 50m off Boga Boga village on Cap Vogel; View of fuselage and tail plane; Cockpit and rear gun

Bruce Johnson also managed to satisfy his intense desire to reach the cockpit, which meant finding his way through the dark bomb bay and many dangling control cables, to become the first person in over 40 years to sit in the pilot's chair.

Black Jack documentary

So unique was the discovery of Black Jack that it led to a documentary being made the following year by a team of nine Australian divers and underwater cameramen together with Rod Pierce, Bruce Johnson and David Pennefather.

Making a documentary about a plane wreck in a remote location in 50m of water is a significant undertaking and required eight months of detailed planning, major logistic support from Rod Pearce on *MV Barbarian* and two teams of divers for eight days to get the footage.

Australian aviation writer, Steve Birdsall, provided a very interesting aspect to the film, when he managed to locate Ralph De Loach in Marina del Rey, California, USA. De Loach had completed his service at the end of WWII and returned to civilian life where he went on to become one of the famous Marlboro Men—the advertising icons created by the tobacco company Phillip Morris to sell their Marlboro cigarettes.

Birdsall arranged for the 69-year-old De Loach to return to Cape Vogel where he was reunited with some of the villagers who had helped get him and his crew safely to shore when Black Jack was ditched in 1943.

The completed film, *Black Jack's Last Mission*, was very successful and was shown on television around the world and is still available on DVD.

Diving the Black Jack

The really special thing about the Black

CLOCWISE FROM LEFT: Boga Boga villagers selling wares; Fisherman from Boga Boga village; Boga Boga village and its fringing reef; Tufi Dive's dive boat on the beach at Boga Boga village

Jack is the fact that the plane is so intact and sitting as she is, on a sandy seabed in clear blue waters with visibility that can easily reach 40+, it's almost like diving a set from a Hollywood movie.

The nose is badly crumpled from the impact of the crash landing and the propellers on the four engines are somewhat twisted, but the rest of the plane is basically all there, which is quite remarkable after over 66 years underwater.

Apparently the plane sank within 45 seconds of coming to a halt, and the crew only just had time to scramble out with the three wounded members. This meant that, apart from two waist guns and the radio transmitters which were jettisoned prior to ditching, Black Jack took all its contents with it to the sea floor.

Pierce, Johnson and Pennefather found machine guns still in their turrets with hundreds of rounds of ammunition in the tracks to the guns and the twin tail guns could still be moved freely in their mounts.

The other very significant thing about the Black Jack is that at nearly 50m depth, she is at the very limits of recreational diving, and although it's a straightforward dive in as much as the water is clear and there are no major hazards or obstructions outside of the plane, decompression and bottom time are critical to a safe overall experience.

Two divers are reported to have lost their lives diving Black Jack since it was discovered in 1986, so it has to be said that this is a dive only for the experienced and competent.

There is a permanent guideline from the shallow reef, which leads divers down the slope, and at around 15m, divers will be able to see the wreck below. There is usually a fairly strong current that sweeps along the slope, so the line is good for guiding divers and providing a reference point—particularly so on the way back.

The line goes all the way down quite close to the huge tail of the wreck, and from there, one should head to the front of the plane to take in its full size. Entry into the plane is possible, but given the depth of the wreck, the extreme likelihood of nitrogen narcosis and all the potential hazards inside, only the most foolish would even consider doing that—just don't go there.

A much safer option is to look inside the cockpit, as the windows are open.

The current is usually strongest out in front of the plane and swimming against it will increase one's air consumption even more, so take great caution with air supply and retain half a tank for the ascent and inevitable deco stop on the rope.

Operators

- Tufi Dive Resort (www.tufidive.com): It is a about a two-hour trip across Collingwood Bay from Cape Nelson to Boga Boga, and one will need good weather to do it, but Tufi Dive does the Black Jack regularly on special request. I dived Black Jack with Tufi Dive, and both Glenn and Archie, the dive leaders at the resort, know the wreck well and how to dive it safely.
- Rod Pearce (www.niuginidiving.com) includes Black Jack on his wreck diving specials on his boat *MV Barbarian,* so divers can combine diving the wreck with meeting one of the men who discovered it!
- Craig de Wit on *Golden Dawn* (www.mvgoldendawn.com) includes Black Jack as part of the Milne Bay itinerary, which the boat does at certain times of the year. I first dove Black Jack from *Golden Dawn* back in about 2001, and de Wit also knows the wreck well and how to dive it safely. ■

Don Silcock is a dive writer and underwater photographer from north west England now based in Sydney, Australia. For more information and images, visit: ***indopacificimages.com***