

Monofins for Freediving

We have been intermittently following the debate concerning the use of the monofin in freediving and would like to share some of our findings.

Two years ago we put together the first experimental monofin/freedive clinic where we assembled some unique elements. We put together the leading trainers in monofin swimming, namely the Russian coaches from Tomsk university, who train both the Russian national team and their chief rivals, the Chinese, the leading specialist monofin manufacturer belonging to the same school and a group of freedivers which represented the best cross-section, from the very top of freediving competition to the very novice. This same group also represented advanced freedivers who already had experience with the monofin, advanced freedivers who had never used a monofin and a novice freediver with no experience of the monofin.

Although the number of freedivers involved was small we feel that with a larger group the conclusions would have been much the same.

The objectives were to find

- (i) What style and why?
- (ii) What rhythm and amplitude of movement?
- (iii) What kind of monofin and what stiffness of blade and if this was individual what the relevant criteria for monofin choice should be?
- (iv) What compromises and adaptations had to be made to suit the specific needs of the freediver?
- (v) What was the best training method for the monofin freediver.

What style and why?

We had heard a lot of talk concerning adaptations of the 'classic' style that freedivers should adopt. I know from personal acquaintance that some of the people recommending various adaptations were not capable of demonstrating a good classic style hence their recommendations were from lack of ability in the monofin and hence lack of choice through limited ability. One does not have to be a professor of hydrodynamics nor be on intimate terms with Newton's Second Law, Reynold's Law and the Law of laminar flow in order to work out that certain of the adaptations don't make sense.

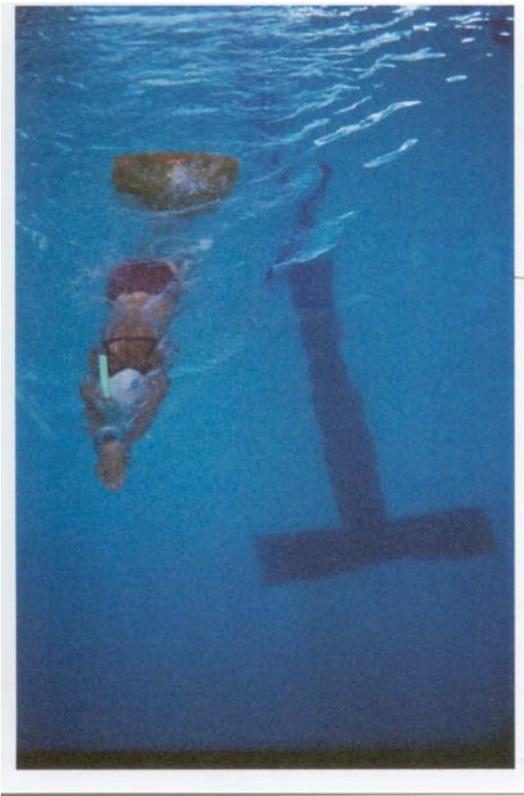
Three persistent faults, which seem to be common are,

- (a) The 'plank' where the freediver kicks from the knee only where the rest of the body is held rigid. This gives a 'start-stop' effect, which may be amusing but is hardly efficient.

- (b) The 'snake' with very graceful undulations of the body including the arms and fingertips. This enables the freediver to cover twice the distance to achieve the same depth!
- (c) 'Let's call this one 'bob' where the hands are held down by the side of the body. This very often combines the best of both worlds where the head and shoulders act as the snake and the knees behave like the 'plank' monofinner.

Lets keep in mind what the 'classic' position was developed to achieve.

- (a) The least possible frontal resistance to moving through a very dense medium
- (b) To occupy the minimum effective space in the water column.
- (c) To effectively move the wave down the body starting from the shoulders, and not the fingers, through the hips and finally into the feet with a minimum bend in the knees, with the biggest amplitude at the feet.



In the 'Classic' position the arms are locked straight above the head, with the biceps in full contact with the back of the head hugging the ears, one palm is placed on top of the bottom hand, fingers extended but pointing down, the thumb of the upper hand locks the bottom hand in place. The wrists are held at about 15 degrees bent down in the line of travel. The head is straight but the chin is slightly tucked down. The arms in this position serve as a counter balance to the undulation of the rest of the body as well as providing

the best hydrodynamic presentation to the water. In a correct movement, for example, when surface swimming, the arms remain straight and extended at all times and hardly leave the surface at all, i.e no dipping down on the downstroke of the monofin. An easily observed common mistake to avoid occurs when a beginner monofinner's head, front snorkel, and fingers disappear below the surface by up to half a meter or more when trying to swim forwards in a straight line!

Another common fault is what we call, the 'clockwork butler'. For those who due to stiffness in the shoulders and upper back, are incapable of achieving the 'classic' position with their arms, use the hands down position with their arms against their thighs, they achieve a movement reminiscent of a butler welcoming a line of fast moving guests. The Russian technique in the hands down position is where the hands are clasped in front of the groin and the shoulders are hunched and rounded slightly so that the whole upper body with the head resembles the front half of a pilot whale. When surface swimming using this technique the art is to see that the snorkel never disappears under the surface and ideally, nearly the same amount of snorkel is visible above the surface the whole time. As the downstroke is initiated the shoulders, neck, and extended arms lift rather than sink.

And what has all this got to do with Freediving?

Rhythm and amplitude of movement?

One of the first questions the freediver wants solved is, 'which is the most efficient style?' This in effect means the most efficient both from the point of view of oxygen consumption and movement through the water. There is a lot to be learned from the studies on biomechanics and changes in buoyancy at depth in dolphins, see Randolph Skrovan, T.M. Williams, P.S. Berry, P.W. Moore and R.W. Davis "The Diving Physiology of Bottlenose Dolphins (*Tursiops Truncatus*).

Dolphins, for example, and the human breath-hold diver, share the same problems of trying to maximize the use of a limited oxygen supply with energy loss through movement during breath-hold dives. A study of the tactics of the dolphin's movement in handling this particular issue is very revealing. In the initial phases of descents and ascents in dives to 100m, there is a period lasting several seconds of large amplitude strokes (representing 20% - 50% of body length) during the maximum effort phases of descent and ascent in overcoming the problems of buoyancy on the surface and at depth, drag after the turn around. This was followed by a phase of '*normal*' stroke rate and amplitude, which would correspond to a normal horizontal swimming gait and this in turn was followed by a '*burst and glide*' pattern of strokes down to the period of negative deceleration, i.e. the point at which if the dolphin were to stop stroking there would be no

deceleration. Also as the dolphin changed pacing intermittently from an active swim to the glide the amplitude of its stroke also changed to a smaller stroke (less than 20% of body length). The final phase of the descent is the 'glide'.

In the paper mentioned above, they very interestingly succeeded in quantifying the energy-saving factor of these particular tactics. *'By incorporating a prolonged glide period the bottlenose dolphin realized a theoretical up to 21% energetic saving in the cost of a 100m dive in comparison with dives based on neutral buoyancy models. Thus modifying locomotor patterns to account for physical changes with depth appears to be one mechanism that enables diving mammals with limited O2 stores to extend the duration of a dive.'* and extend its diving depth range.

Though we have not been able to quantify this in our experience with human freedivers we have long suspected a parallel. When teaching the 'dry' breath-hold walk with or without a static phase at the beginning of between 1:00 and 2:00 minutes, we found that this had little effect on the total distance covered or only produced marginally shorter distance than the breath-hold walk with no static period. Here if we can make a comparison between this static phase and the non-deceleration glide phase of the dolphin we can deduce that there is substantial energy conservation during periods of no activity but where movement is still taking place. In the phase immediately prior to this during the 'burst and glide' it was found in the case of the dolphin that the effort required for re-acceleration following a glide was more than compensated for by the energy conservation of the glide itself. What one can deduce from this is that in this phase there is a very high priority placed upon hydrodynamicism to maximize the efficiency of the glide and limit the energy cost of re-acceleration. Hence, for the freediver, the 'classic' position.



The tactics of the dolphin should suggest to a trainer or coach tactics applicable to their freediver; i.e. how many strokes maximum effort on the initial phase of descent and ascent, perhaps a priority given to training the BTV method of equalization, at what depth neutral buoyancy should be achieved, at what depth to change to the 'burst and glide', and at what depth the point of negative deceleration is achieved to enter the total 'glide' phase?

I still retain the picture in my head of two young Greek girls in monofins employing the undulation and glide technique. They had been in the hands of one of the best Russian trainers and were doing warm up laps in synchronization with each other for more than 40 minutes in the outdoor Olympic training pool in Agios Kosmas, in Athens. Each turn was perfectly co-ordinated with exactly 25 movements to cover every 50m. They were the epitome of effortless grace and made me take the

vow that that was what I was going to try to achieve when using a monofin in the water.

Today we have some superb freedivers with the bi-fin, we have some excellent freedivers with the monofin but no really top freedivers with a real mastery of the monofin. One knows immediately and without further philosophy that the monofin is the ultimate tool for the Fixed Weights freediver and that the classic style, once understood and mastered, could make the already good freedivers, surpass the limits they are achieving today.

Sadly one of the objectives we wanted to achieve in the clinic was to teach one of the top Russian monofinners how to freedive but under the circumstances, although this would have been a very interesting project, their world finswimming performances depend on total dedication to their specific training. However my conviction remains that when these athletes get into freediving the records will tumble even further.

One of the objectives was to compare the efficiency of 'hands down', Russian version, and the 'classic' position over 50m dynamic. In every case after many repetitions by all the freedivers, hands down required about 25% to 30% more movement to cover the same distance and the times were in comparably longer. Any claim for this being more oxygen efficient is negligible. Both the trainers and the participants agreed that from an oxygen conservation point of view a large amplitude stroke was more efficient during breath-hold dives, and not the fast high frequency, short amplitude of the 50m sprint finner.

What kind of monofin and what stiffness of blade for FIXED WEIGHTS?

As the stroke is fin dependent, we achieved our second objective concerning the type of monofin best suited to freediving. We concluded with the observations of our Russian trainers that the flexibility should be somewhere between a long distance, (soft), to middle distance (medium soft) fin and in relation to an individual's muscle structure and weight and that the length of the fin should be in proportion to his/her height and leg length. Fine-tuning this depended quite a lot on the effectiveness of the first kick after the duck dive. Here it became apparent whether a person was using too stiff a blade or a blade, which wasn't stiff enough. Everybody also agreed that the Waterway footpocket, for a generic fin was superior to any of the other production line fins and their blades were also of excellent quality and price.

Three days before the start of the clinic, Davide Carrera, who had just done 91m Free Immersion for a FIPS (Italian standards committee) record, and who is easily capable of more than 76m in Fixed Weights, together with Maria-Teresa and myself, tested the construction of the new 'WING' EGOISTE' fin, hand manufactured by the SKATE team. The fin in its construction has an angled footpocket to allow the ultimate position of fin to body line during movement. It has two side ribs made of neoprene to afford a cupping action and out of the water weighs 7kgs. On the surface however it is neutrally buoyant. At depth (tested to 60m), the neoprene compressed and suddenly one had 7kgs extra to deal with and a badly compressed foot. Fortunately for freedivers, especially as it is a

custom made specialist professional fin costing in the region of around \$1000 or more, in its present configuration it is not applicable to Fixed Weights or Variable!

Compromises and adaptations

Unlike finswimming where the resistance experienced by a finswimmer is constant Messrs Archimedes and Boyle/ Marriot have ensured that the resistances opposed to the freediver are variable, hydrodynamics and buoyancy. The first part of the descent poses the maximum resistance together with the first part of the ascent. Here, unequivocally, the 'classic' style is preferred, but here again there is a big problem as anyone who is not capable of BTV (equalizing without use of the hands), is under a grave disadvantage. Therefore this has led us to prioritise and develop effective techniques for teaching BTV to monofinners, though in the last analysis not everyone is physiologically equally capable of applying it.

The general feeling regarding changing styles during the dive concerns the debate of where resistance was minimal, i.e. during the glide on descent and during the last part of the ascent, where the buoyancy equation works in one's favour and conservation of effort is a priority. Here the hands down position might facilitate equalization in the glide and would help with relaxation both in the last parts of the descent and ascent. However, most people experienced greater difficulties in maintaining direction or spiralled during the glide and reaching for the tag was more complicated. The conclusion was a slightly more relaxed version of the classic position during the glide and a breast-stroke pull down in the last few metres of the ascent before surfacing.

Monofin Training

Concerning training it became apparent from the start that the Russians take no prisoners. They had a murderous 40 minute stretching programme for us prior to getting into the pool for the 1200m – 1800m training sessions. For nearly every stretch the hands had to be held above the head to simulate the monofin position. Their attitude was NOT that if you find it difficult just keep your hands down whilst swimming but rather stretch until you have achieved the necessary mobility in the shoulders! As an old Indian yoga master of ours always says, under any difficulty, '*Practice, all is coming!*'

The morning sessions were totally restricted to using small rubber bi-fins of a particular type, which are rather like a small split monofin. There followed various exercises and 1200m of timed drills, i.e. interval training. The afternoon sessions were held in the bay on a 50m extended weighted line set in a depth of about 1.5m, where we did 100m drills using various techniques for style and speed. Most of the training concerned surface drills and interval training with a few sessions ending in subsurface sprint exercises.

Conclusions

It is not our intention to be dogmatic and insist that the 'classic style' without any adaptation be the only one for Fixed Weights however there was a consensus on two major points. The first point was in the benefits of learning correct style. This includes everything concerned with achieving this, such as correct stretching, preparation and the most appropriate drills for the improvement of style for muscle conditioning. The second point is that in order to have an informed opinion it is necessary first to master the correct style otherwise one has no true understanding or feeling for what has to be achieved.

The 10-day duration of the clinic, although the students worked very hard, was insufficient to produce a dramatic change in aerobic and anaerobic fitness levels, though there may have been some change here too. The Russians decided that the training distances should remain at about 1800m per session, i.e twice a day, as they did not reckon that the mean average fitness of the group could have coped at that stage with much more. Conditions did not permit us to take blood samples for more accurate scientific testing however times and pulse rates were carefully monitored throughout for each individual monofin on the surface and in apnea over 50m both at the beginning and at the end of the course. In every individual the very large improvement in sprint times over 50m surface and in apnea times adequately demonstrated the effectiveness of style training in the monofin which proved to be directly applicable to their depth performances. Bevan Dewar, the south African participant gained 15m depth over the 10 day monofin course and immediately after the course unofficially broke Trevor Hutton's old record of 55m by one metre and the next day successfully passed the 60m mark. Shortly after MT did her own pb of 60m and Emma Farrell, the novice monofinner dove to 32m for the first time. Haydn Welch the UK record holder for dynamic later did as he put it, a 'very easy' pb in the competition in Cyprus, to 55m in his Fixed Weights dive with the feeling that he could have sprinted it!