World as it is

Extremely deep bounce dives: planning and physiological challenges based on the experiences of a sample of French-speaking technical divers

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Abstract
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Introduction: Extreme deep technical diving presents significant physiological challenges. While procedures often blend elements from both recreational and commercial diving, many remain empirical and unvalidated for this purpose. The rise of closed-circuit rebreathers has reduced gas cost and logistical barriers, enabling more divers to reach unprecedented depths. This study, based on the experience of deep divers, explores the limits of extreme-depth diving and the strategies developed to overcome them.
Methods: Eight rebreather divers (one female, seven males) with experience beyond 200 metres depth were interviewed regarding their preparation, planning, and execution of such dives. The dive profiles of their deepest dives were analysed.
Results: All were highly experienced technical divers. The median maximal depth was 227 [209–302] metres, with a median total dive time of 290 [271–395] minutes. The gas density of the trimix mixture, oxygen exposure, and ascent rate consistently exceeded current recommendations. High pressure nervous syndrome did not appear to be a major limiting factor, whereas decompression posed greater challenges. Three divers experienced decompression sickness following their deepest dives, highlighting the uncertainty around decompression procedures.
Conclusions: These dives require rigorous preparation, robust support systems, equipment modifications, and perfect skills to reduce risks, which remain excessively high. Data are lacking to validate current practices. Decompression procedures must be adapted for these demanding mixed-gas dives, which are inevitably prolonged. A dry underwater habitat could improve decompression tolerance. The role of hydrogen as a breathing gas remains uncertain and still needs to be clarified, but some consider it a promising avenue for further exploration.

Introduction

Scuba diving is widely regarded as a recreational activity, typically involving shallow compressed-air open-circuit dives within no-decompression limits. However, advancements in specialised equipment and helium-based mixed gases have significantly expanded the possibilities for deeper and longer dives. Adding helium reduces nitrogen narcosis and gas density, allowing divers to explore depths once considered unreachable.[1] Closed-circuit rebreathers (CCR) are further revolutionising deep underwater exploration, enhancing efficiency and safety.[1,2] As a result, participation in non-commercial extreme-depth dives has surged, accompanied by record-breaking achievements. While depths of 100–150 m are now relatively common, some divers have exceeded 300 m.

Extreme deep technical diving poses significant physiological challenges and heightened hazards associated with exceeding recreational limits. These risks encompass technical failures, decompression sickness, oxygen toxicity, carbon dioxide (CO_2) retention, high-pressure nervous syndrome (HPNS), hypothermia,[1,3–6] and an increased likelihood of fatalities.[7] Equipment and processes must be adapted to the unique demands of these deep bounce dives, inspired by those developed for deep occupational diving, although the contexts of practices differ significantly.[8,9]

An increasing number of technical divers are pushing beyond conventional diving limits, occasionally sharing their experiences through individual online articles or in the specialised press. This article aims to examine the preparation and practices involved in these extremely deep dives, which frequently exceed current guidelines for technical bounce diving, a domain that remains largely uncharted. By these narratives, we will discuss these limits, and the solutions implemented to attempt to overcome them.

Methods

This study was approved by the data protection officer of the University of Western Brittany in accordance with the European Union's General Data Protection Regulation (Réf-ORPHY24229). All divers provided consent for data analysis.

The technical diving community is relatively small, with a limited number of divers having reached extreme depths. Known experienced 'very deep' technical divers from the French-speaking community were invited to participate in the study. To ensure relevance and minimise memory bias, the study focused on divers whose personal deepest dives exceeded 200 m and were conducted within the past two years. This depth limit is purely arbitrary but introduces additional physiological and logistical constraints, while experience in 'middle-range' deep diving (i.e., 100–150 m) continues to grow. Semi-structured interviews were conducted by phone between November and December 2024. The average call duration was 69 minutes [IQR 40–107].

The interview was divided into three sections. The first covered demographic data, diving experience, and significant diving-related incidents history. Participants provided details on their dive certifications, total number of dives, and deep dive experience before their first 200 m dive. The second section explored physical, nutritional, mental, and technical preparation for deep diving projects. Divers shared information on their training routines, dietary adjustments, and hydration strategies before dives. Additionally, they were asked about their mental preparation, the factors motivating them to undertake these dives, and any guidance they received from deep diving experts, including divers, physicians, or physiologists. The final section focused on the planning and execution of their deepest dive. Data on the diving environment (location, water temperature) and equipment (breathing apparatus, redundancy, mixed gas, decompression algorithm, conservatism, etc.) were collected. The dive profile was analysed, including the maximum depth reached, descent duration, ascent speed to the first stop, and partial pressures of oxygen (PO_2) used. Any incidents or accidents during these dives were also investigated, along with their outcomes.

STATISTICAL ANALYSIS

Statistical analysis was performed with GraphPad Prism v10.4.1 (GraphPad Software Inc., San Diego, CA, USA). Most responses were analysed descriptively, and continuous variables were presented as median [interquartile range].

Results

A total of eight divers (one female / seven males), aged 44 [34–55] years, were interviewed. Their median body mass index was 24.6 [22.7–26.5] $kg.m^{-2}$. Six divers reported having experienced decompression sickness symptoms (DCS) on previous dives. Only one diver received hyperbaric oxygen (HBO) treatment, while three others performed in-water recompression (IWR), primarily when symptoms appeared before surfacing. Additionally, three divers reported having previously experienced symptoms consistent with HPNS.

At the time of attempting their first 200 m dives, their median age was 37 [33–43] years old. They had accumulated 22 [11–26] years of diving experience and 11 [6–16] years of trimix certification. They had logged 2,000 [600–3,000] dives, including 163 [70–200] to depths of up to 100 m. At the time of the interview, they had completed 8 [2–48] dives beyond 200 m, with individual experience ranging from one to 150 such dives. All cave divers expressed a strong drive for exploration and pushing boundaries. Five divers aimed to break records, while two were motivated by a marine-scientific interest in documenting extreme-deep environments.

PREPARATION FOR DEEP DIVE PROJECT

In preparation for these dives, seven divers intensified their physical training through endurance and aerobic exercises for 6 [3–6] hours per week. Two of them incorporated strength training. Regarding diet, only two divers made adjustments, focusing on high-protein foods or slow-release carbohydrates during the preparation phase. Hydration was a key focus for four divers, who reported consuming at least 2,000 ml of water per day in the week leading up to the dive. Mental preparation varied among participants. The three divers with fewer than five extreme deep dive experiences practiced pre-dive verification rituals (e.g., visualisation exercises, mental rehearsal of problem-solving strategies, etc.) while more experienced divers relied on intuition and self-awareness to mitigate unnecessary risks. However, all divers consistently performed a pre-dive checklist. Technical preparation mainly involved frequent deep dives in the weeks leading up to the record dive for at least five of them. Two divers reported testing all their backup equipment at

Table 1

Extreme deep dives parameters; all PO_2 diluent, equivalent narcotic depth (END) and gas density calculations were made based on the mixed gas in the diluent cylinder at maximal depth.[1] CCR – closed circuit rebreather; Environ – diving environment; GF – gradient factors; gradient factors are expressed by a combination of low / high; OW – open water; SP – set point for PO_2 selected by the diver; Rebreathers – JJ-CCR (JJ ApS, Presto, Denmark), Megalodon CCR (Innerspace System Corp, South Hallsville, TX, USA), X-CCR (iQSub Technologies s.r.o, Orlova, Czech Republic), Liberty sidemount CCR (Divesoft s.r.o, Hálkova, Czech Republic), Joky mCCR (Homemade rebreather, designed by Frédéric Badiér, France); *indicates redundancy by a second rebreather (model may be different from the primary apparatus)

Environ	Personal depth record (m)	Primary rebreather model	GF	Mixed gas (O_2/He)	PO_2 SP (bar)	END (m)	PO_2 diluent (bar)	Gas density ($g.L^{-1}$)
					At maximal depth			
OW	202	JJ-CCR	20/60	5/80	1.3	30	1.1	8.54
OW	204	JJ-CCR	30/60	5/79	1.3	33	1.1	8.85
OW	223	Megalodon*	50/80	4/82	1.4	31	0.9	8.85
OW	224	Megalodon*	85/85	4/85	1.3	23	0.9	8.14
Cave	230	Megalodon	70/85	5/80	1.4	36	1.2	9.67
Cave	285	X-CCR	45/80	2/93	1.6	9	0.6	7.63
Cave	308	Liberty SM*	80/80	4/87	1.2	26	1.3	10.38
Cave	312	Joky*	40/80	4/86	1.6	31	1.3	10.85
Median [IQR]	227 [209–302]				1.4 [1.3–1.6]	31 [24–33]	1.1 [0.9–1.3]	8.85 [8.24–10.2]

great depths during their training dives. Beyond personal experience and discussions with diving community, five divers sought advice from physiologists and decompression specialists to refine their dive plans.

PLANNING AND EXECUTION

Although some divers initially used open circuit systems for their first deep dives, all now consider CCR essential for record-setting dives (Table 1). Four divers use a redundant CCR setup, and two others are considering adopting this configuration for next projects. All divers used drysuit, with five incorporating active heating system for thermal protection. Diver propulsion vehicles (DPVs) were universally used, with two cave divers employing a redundant DPV for added safety (Figure 1).

Decompression was managed using the Bühlmann model, and all dives were conducted with Trimix mixtures (Table 1). The water temperature was 18.5 [18–20.5]°C. The maximal depth was 227 [209–302] m, with a total dive time of 290 [271–395] minutes. The descent took 14 [9–17] min at a rate of 18 [16–24] $m{\cdot}min^{-1}$. The ascent speed prior the first decompression stop was 16 [9–28] $m{\cdot}min^{-1}$. The PO_2 set points were respectively 1.4 [1.3–1.6], 1.6 [1.3–1.8] and 1.6 [1.5–1.6] bar during the bottom time, during ascent and during the last decompression stops. All divers reported significantly exceeding the 100% oxygen central nervous system (CNS) clock limits. One diver reported taking 'air breaks' during decompression to reduce the risk of oxygen toxicity. An example of this diving profile is shown in Figure 2.

The four cave divers reached the bottom solo. One completed the entire dive alone, while the others had safety divers meeting them around 100–120 m during ascent. Open water divers were supported by surface safety team and a dive buddy. Five divers reported a specific emergency plan, and three notified hyperbaric medical facilities before their dives. One cave diver deployed a diving bell at 12 m to enhance decompression comfort and safety.

The two dives exceeding 300 m were complicated by severe DCS symptoms during ascent, including inner-ear and pulmonary 'chokes' manifestations. In-water DCS events were self-managed through oxygen adjustments and brief recompression by descending slightly before resuming ascent. All symptoms resolved before surface. Another diver suffered musculoskeletal DCS after surfacing, and he received medical treatment with no HBO therapy due to the remote location and the rapid favorable outcome. All reported complete recovery.

Figure 1
Photo of an extreme deep diver and his equipment (Reproduced with permission from A. Legrix and F. Swierczynski ©Photosub)

Figure 2
An example of a very deep diving profile (courtesy of X. Meniscus); the dark grey area indicates the calculated decompression profile

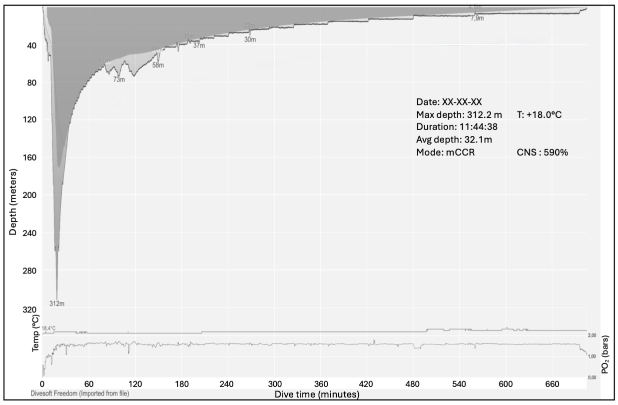

Table 2
Summary of currently known diving records using data retrieved from openly accessible online sources; Environ – diving environment; *Deepest scuba dive validated by the Guinness World Records for male (♂) and female (♀) divers (https://www.guinnessworldrecords.com)

Environ	Open water				Cave			
Diver	Depth (m)	Holder	Location	Year	Depth (m)	Holder	Location	Year
♀ OC	211	C. Serpieri	?	?	246*	K. van den Oever	Boesmansgat (South Africa)	2022
♂ OC	332*	A. Gabr	Dahab (Egypt)	2014	283	N. Gomes	Boesmansgat (South Africa)	1996
♀ CCR	222	G. Giesen	Cassis (France)	2024	?	?	?	?
♂ CCR	316	J. Macedonski	Lake Garda (Italy)	2018	312	X. Meniscus	Font Estramar (France)	2024

Discussion

The current deepest bounce dive is held by Ahmed Gabr who reached 332 m in seawater for a 14-hour dive time in 2014 (Table 2). It seems likely that other divers will attempt to approach this milestone, and those attempts will carry great risk. The use of CCR technology in deep diving simplifies gas cylinder logistics and lowers costs compared to similar dives on open circuit. This makes such attempts more accessible to divers. The current 'safe' operational limit would be around 150–200 m.[2] The crucial advantage of a CCR is recycling the exhaled gas through a CO_2 absorbent, significantly increasing gas autonomy independent of depth, and thereby extending the limits of exploration.[1] To accomplish these dives, divers must deal with many challenges. The interviewed divers were highly trained and experienced. However, making extreme depths more accessible might expose less experienced and less 'physiologically prepared' divers to perilous situations. The pursuit of records can sometimes lead to catastrophic outcomes.[10]

RIGOROUS PREPARATION

Physical fitness is essential to ensure adequate functional capacity for the normal and emergent demands of diving.[11] Some evidence suggests that higher aerobic fitness may reduce decompression stress.[12] While divers preparing for these highly demanding explorations seem aware of this, 20% of technical divers report low physical activity.[6] Hydration receives significant attention by divers. Although hydration status is widely perceived as a DCS risk factor, evidence remains inconclusive in humans.[12] The optimal fluid intake before and during a dive is unknown, but one study found that consuming 1,300 ml of fluid before diving reduced post-dive circulatory bubbles and helped to limit dehydration.[13] Dive duration may exacerbate this effect, potentially requiring greater fluid intake throughout the dive. Many technical divers mitigate this by hydrating in-water using flexible bottles. Conversely, some authors have suggested that hyperhydration may increase the risk of immersion pulmonary oedema (IPO). However, this remains a subject of debate in scuba diving, where physical exertion, water temperature, and breathing resistance from equipment are considered the primary extrinsic risk factors.[14] Energy expenditure increases during the dive, rising disproportionately beyond 200 m.[15] Despite this, many divers reported consuming only a light meal beforehand. Insufficient intake during prolonged dives may impair thermal regulation and cognitive function. Consuming water, condensed milk or stews during decompression stops is unlikely to fully compensate for this negative balance. Pre-dive nutrition may also influence decompression stress. Some data suggest that a ketogenic or antioxidant diet could help counteract diving-induced oxidative stress and inflammation, both suspected contributors to DCS, but a related preventative role remains untested at this time.[12,15]

These dives require self-control, effective stress management, and the ability to handle unpredictable events while maintaining situational awareness.[10] Divers gathered information from various sources to refine planning, gain experience, and minimise risks, though many unknowns remain. However, it is impossible to determine to what extent these factors influence planning. A specific emergency plan is crucial, as rescue operations at extreme depths are logistically complex and hazardous. Risk prevention and optimised emergency response require rigorous training.[16] When conducted privately, these dives present certain ethical and economic considerations for initiators. However, operating outside a professional framework enables divers to push outside the regulations and conventional limits.[5]

HELIUM MIXED-GASES AND DECOMPRESSION CONSIDERATIONS

From a physiological perspective, gas density and HPNS are factors limiting access to extreme depths.[5] In bounce dives, however, the very long in-water decompressions appear to be the primary challenge. Nitrogen narcosis is easily mitigated by replacing nitrogen with helium in mixed gases.[1] Helium, being significantly lighter than nitrogen, reduces breathing gas density. However, gas density increases proportionally with depth, rapidly exceeding the critical 6.2 $g \cdot L^{-1}$ threshold at extreme depths.[17] This raises airway resistance, breathing effort, and limits ventilation, leading to CO_2 retention and cardiopulmonary constraints.[5,18,19] These risks are often underestimated by technical divers and become unmanageable at these ranges of depth.[6] For instance, at 250 m with a 4% oxygen and 96% helium mix, gas density reaches 6.3 $g \cdot L^{-1}$. Eliminating nitrogen entirely introduces other challenges, as discussed below. Many technical divers exceed this threshold without exhibiting evident adverse effects. This limit, based on limited data, remains uncertain and further research is needed.[6,17] Preventive strategies for divers include reducing gas density and utilising DPVs to minimise exertion and CO_2 production. However, hypercapnia can impair work capacity, cognition, and decompression safety. It also lowers seizure thresholds, and has been linked to fatalities.[3] Recognition is challenging, and subjective symptoms are often ignored. In this context, reliable respiratory circuit monitoring is essential to enhance safety. In addition, the rebreather itself may contribute to increased respiratory workload. Back-mounted counterlungs exacerbate hydrostatic imbalance creating a negative static lung load, particularly in the prone position. This may amplify the negative transpulmonary pressure gradient, potentially promoting IPO. It has been suggested that chest-mounted or side-mounted counterlungs, positioned in front of the shoulders, may have a beneficial effect.[14,19]

HPNS is well-documented in saturation diving.[20] Symptoms include cognitive impairment, dizziness, visual disturbances, nausea, drowsiness, muscle tremors, and coordination issues.[5,21] Symptom severity depends on compression rate and hydrostatic pressure.[21] Severe impairments of judgment and motor coordination alteration may contribute to fatalities during deep bounce dives. However, HPNS was generally not reported above 250 m among respondent divers, though individual susceptibility varies.[5,22] Additionally, the absence of physical exertion and the normothermia at the beginning of the dive (unlike hyperthermia induced by compression in dry chambers) could contribute to the mild impact of these symptoms, despite the rapid compression rate.[23] The duration of exposure at depth may also be insufficient for severe neuro-motor symptoms to develop. Finally, adding 5–8% nitrogen to the gas mix helps control symptoms, though exceeding 10% increases the risk of nitrogen narcosis and increases gas density.[21]

The high inert gas load presents significant challenges for safe decompression with divers adopting and accustomed to different approaches at these extreme depths. This is especially critical as no validated decompression protocol exists for such dives, and some models penalise high-helium mixtures extending decompression requirements.[24] Decompression obligations are rapidly accumulated and divers spent 96% of their diving time in ascent. Their goal is to minimise total dive time without compromising safety. In helium-based saturation decompression, ascent is very slow and conducted in a dry, heated, and controlled environment.[20] In contrast, to limit the saturation of slow-tissue compartments and to reduce decompression time, deep bounce divers interviewed used faster ascent rates than the recommended 6–10 $m \cdot min^{-1}$ by technical diving standards.[25] Nevertheless, there are no data supporting this practice, so perhaps slower rates should be respected while accepting the extended decompression this requires.

Decompression profiles can also be adjusted using gradient factors (GF), where the low-GF influences the depth of the first stop, and the high-GF affects shallower stop duration. Decompression strategies vary widely, often based on personal experience and GF is not directly linked to experimentally validated decompression profiles.[6,24] In this context, helium's lower solubility and faster washout may produce more circulating bubbles implicated in the pathophysiology of DCS. High PO_2 reduces inert gas load and accelerates its elimination. All surveyed divers significantly exceeded CNS clock exposure limits, dismissing them as unnecessary. Although optimising the oxygen window offers decompression benefits, using PO_2 levels above the recommended thresholds increases the risk of neurological oxygen toxicity.[25,26] The decompression advantage during the bottom phase remains uncertain. A reasonable compromise would be to initially maintain PO_2 below 1.3 bar, where the reduction in inert gas uptake is relatively modest, in order to preserve the ability to use higher oxygen levels more safely during shallow decompression stop.[6] Intermittent 'air breaks' (typically 5 min every 20 min) during oxygen breathing have been shown to reduce the risk of convulsions in dry chambers. A similar protective effect is presumed in actual diving scenarios; however, data on its feasibility and effectiveness underwater remain limited.[27] Susceptibility to oxygen toxicity varies between individuals and there is no evidence that tolerance improves with practice. This toxicity is cumulative, potentially leading to seizures and drowning, especially during prolonged exposure.[28] While exceeding limits does not appear to cause significant lung function decline, reversible symptoms like chest tightness or dry cough have been reported.[26]

MATERIAL AND ENVIRONMENTAL CONSIDERATIONS

Equipment malfunctions at extreme depths can be catastrophic, as many devices are not designed or certified for such conditions. Several incidents have been reported within the diving community, including the implosion of a DPV at depth, as described by one of the interviewed divers, which could have resulted in a serious secondary accident. Technical divers emphasise the importance of redundant critical systems to ensure a safe return.[16]

Rebreathers address gas volume limitations where the time limiting factor is only the CO_2 absorbent capacity.[1,2] In very deep or prolonged dives, especially in caves where carrying sufficient cylinders is challenging, bailout CCR offers a very attractive redundancy option.[2,29] In open water, decompression gases can be supplied from the surface, but risks such as missing the shot line or losing contact with the support team remain problematic. Compared to OC systems, the use of bailout CCR increases the risk of human-error due to its more complex nature. Moreover, in the event of hypercapnia, a rapid switch to an alternate breathing apparatus is critical. Without a bailout valve (BOV) or an open circuit stage regulator, a second rebreather may reduce CO_2 washout efficiency caused by the re-inhalation of contaminated breathing gas. A BOV integrates an open circuit regulator within the breathing loop mouthpiece, but at extreme depths, regulator performance may be compromised, and an open circuit gas supply might only last just a few minutes. A second consideration in preventing hypercapnia is scrubber duration, which depends on soda lime quality, quantity, proper filling, and storage.[30] Most manufactured scrubbers are designed for three to four hours of efficacy based on testing at 4°C with ventilation and CO_2 addition to simulate a high exertion level. While this is generally sufficient for extended dives in temperate waters with minimal effort, some divers attempt to extend scrubber capacity through homemade modifications or the use of radial scrubbers.

As previously discussed, keeping divers warm and well-hydrated is crucial for effective decompression. Limiting environmental exposure helps mitigate these challenges. Adequate thermal protection is essential, and an active heating system can reduce the risk of hypothermia. However, after a 'warm' period, the heating system may malfunction during decompression, which could be detrimental.[4] Another component of this strategy is the use of dry decompression habitats, which are relatively simple and cost-effective. These habitats provide a refuge during final decompression stops and often induce a 'segmented staged decompression' prolonging the overall runtime and potentially the quality of decompression.[2,31] The diver is comfortably sitting, which allows for fluid and caloric intake, helps improve thermal comfort, and reduces the risk of fatalities in the event of oxygen toxicity.[2,31] Thus, this practice shares many similarities and advantages with saturation diving and might be the 'reasonable' approach to allowing sufficient decompression for these deep dives.

EXCEEDING THE LIMITS?

The present reports from extreme dives highlight a high accident rate, including severe DCS cases, with symptoms emerging in the water that could have led to fatal outcomes. Special attention has been given to inner-ear DCS in technical diving, likely caused by the arterialisation of circulating bubbles, which then pass to the inner ear's terminal circulation in a supersaturated inert gas environment.[12] These findings suggest current decompression procedures and gas management are inadequate for extreme deep dives, underscoring the need for further research to enhance safety. Self-adjustments to reduce decompression time, whether by modifying ascent rates or oxygen exposure, exhibit an element of randomness and could even be dangerous. High skills and experience allow for minimal exertion and perfect stabilisation during dives, reducing respiratory effort and the risk of hypercapnia. This helps mitigate the effects of narcosis, HPNS, oxygen toxicity, and potentially the risk of DCS.[32] However, physical effort may be required in the event of an unexpected situation or equipment failure, which could exacerbate these risks.

It has long been hypothesised that hydrogen-containing gases could enhance safety and performance in extremely deep dives. These mixed gases have enabled the record of deepest dives (534 m in open sea and 701 m in a hyperbaric chamber).[8] A recent report in recreational deep diving suggests hydrogen may mitigate physiological limitations by reducing breathing gas density and alleviating HPNS symptoms.[22] However, careful attention must be given to managing this highly flammable gas and its unknown decompression profile. Additional factors, such as counter-diffusion issues and thermal hazards, also need consideration.[8,33] Unfortunately, a case of severe DCS was recently documented on social media after a hydrogen bounce dive, highlighting the unknown risks and new challenges ahead. The solubility of hydrogen in fats and its diffusion rate could contribute to neurological injury, as previously observed, leading to the termination of the Hydra-Ludion experiments (non-published data, reported by author BG). COMEX reports have shown that while hydrogen effectively reduces HPNS and improves respiratory comfort, it does not allow accelerating decompression compared to helium in saturation diving.

Technological advancements, particularly in real-time diver monitoring, and procedural adjustments remain necessary to push the limits of depth exploration. Divers must approach this challenge with humility, responsibility, curiosity, and an unwavering commitment to safety. In this field, collaboration between the diving and research communities is essential in advancing knowledge and minimising the risks associated with such explorations.

LIMITATIONS

This report has several limitations. Although from different backgrounds, only divers within the researchers' network were contacted, introducing a recruitment bias. Consequently, the study focused on a limited number of highly specialised divers, whose dive planning methods may not be generalisable. Practices vary widely based on individual experience. Additionally, a recall bias may be present, despite the dives being recent and based on computer records. Nonetheless, this study seeks to discuss current practices and explore the future of deep diving and the limits of human endurance.

Conclusions

Extreme deep diving is both exhilarating and demanding, requiring specialised training, advanced equipment, and meticulous planning. This pursuit pushes human limits, as evidenced by record-breaking achievements. Success in extreme deep bounce dives depends on overcoming significant physiological and logistical challenges. Decompression remains a primary obstacle, as ascent rates seem difficult to accelerate regardless of the gas mixture used. Accepting that reaching great depths necessitates an extended decompression period is crucial. Submerged habitats could help mitigate the adverse effects of prolonged time spent in the water. Careful preparation, robust support systems, and continuous protocol advancements are essential for risk mitigation. Additionally, physiological monitoring should play a crucial role in improving safety and assessing divers' tolerance to extreme depths.

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