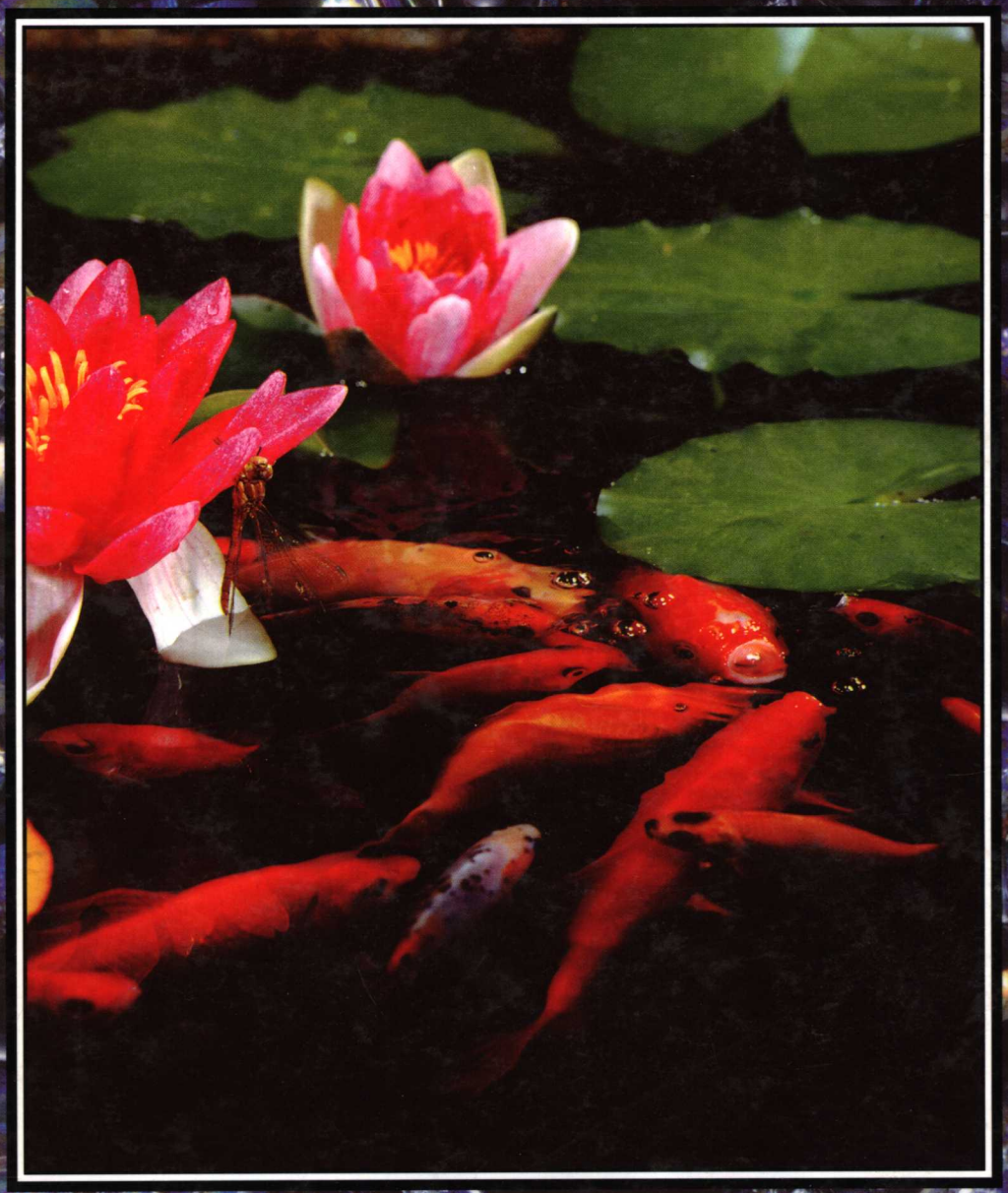
The Nature and Science of BUBBLES

气泡的奥秘



Jane Burton and Kim Taylor 著　钱沪芳 译

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Why are Bubbles Round?
气泡为什么是圆的？

Bubbles form when a gas is released into a liquid. Usually the gas is **air** and the liquid is water. But bubbles of other gases such as **oxygen** form in water and you can have gas bubbles in red-hot molten metal, in molten glass or even in treacle.

When an underwater bubble floats to the surface, it does one of two things: it either bursts and disappears altogether or it forms a floating bubble. A floating bubble is quite different from a bubble under the surface because it not only has gas inside but also *outside*. It consists of just a thin **film** of liquid.

Bubbles tend to be round except when they are in contact with each other or with something solid. Then they can have flat surfaces. The reason for the roundness of bubbles is that they are pulled into shape by a force called **surface tension**. Surface tension acts like an invisible **elastic** skin on the surface of all liquids. A bubble floating in the air has both an inside and an outside surface and so there are two lots of surface tension pulling it into a round shape.

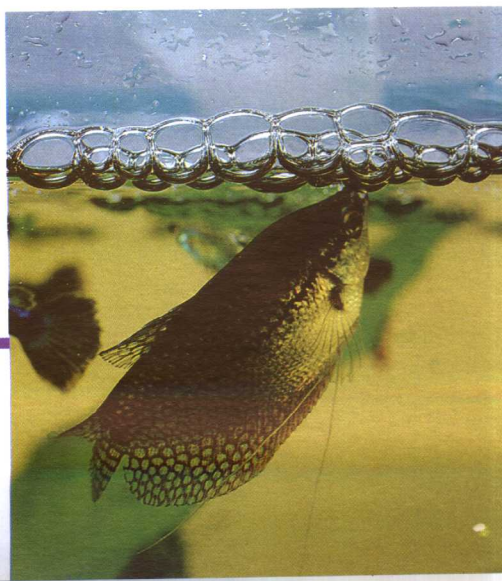
气泡是气体排入液体中时形成的。这种气体通常是空气，而液体则是水。但其他气体比如氧气在水中也能形成气泡。在炽热的金属熔液、玻璃熔液甚至在糖浆中也能看到气泡。

当水下气泡漂浮到水面时，会出现以下两种情况：不是胀破并彻底消失，就是形成一个漂浮的气泡。漂浮的气泡与水下的气泡有很大的区别，即它里外都是气体，仅由薄薄的一层液体构成。

气泡往往是圆的，但当它们相互吸附或附着在固体物质上时，其附着面是平的。气泡之所以是圆的，是因为它们被一种叫做表面张力的力量拉成圆形。表面张力的作用就像一张看不见的富有弹性的皮，它贴附在所有液体表面。在空气中飘浮的气泡内外各有一个表面，这样就有两股表面张力将气泡拉成圆形。

The biggest of these bubbles of oxygen are being pushed towards the surface by the pressure of the water, but they are held by the green weed that has produced them. Instead of being round, they are pear-shaped.
这些氧气气泡中，个儿最大的气泡正被水压推向水面，但也被产生它们的绿色水草吸住。这些气泡并非圆形，而是梨形。

Floating bubbles are attracted to solid objects and to each other. When they touch something, bubbles can have flat sides, like these bubbles resting against the glass of an aquarium.
漂浮的气泡被固体物质吸住，同时相互吸附。当气泡接触到固体时，附着面是平的，就像这些附在鱼缸玻璃上的气泡一样。



Bubbles in Water
水中的气泡

Oxygen bubble produced underwater by green water weed.
由绿色水草在水下产生的氧气气泡。

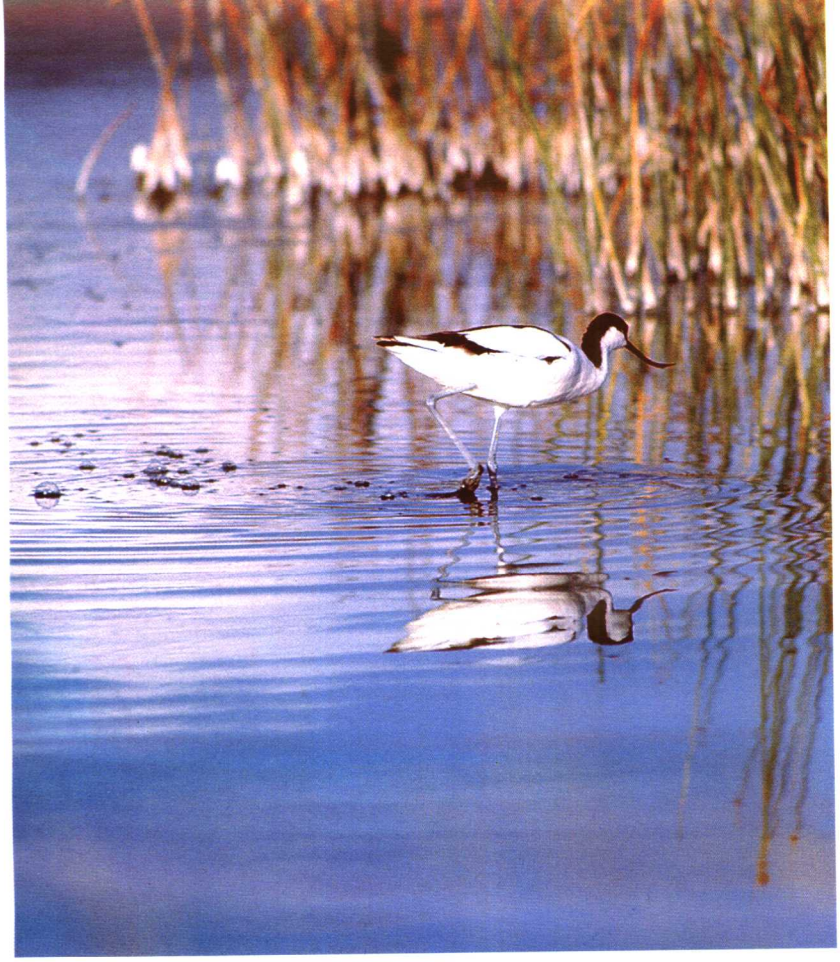
Green plants in sunlight give off oxygen gas and when water plants do this, the gas forms bubbles. You can sometimes see strings of little oxygen bubbles rising slowly from the stems or leaves of water weed in a pond or aquarium. Bigger bubbles rise more quickly. Large bubbles of **methane** sometimes come rushing to the surface of ponds. Methane, or marsh gas, forms under water when dead plant material rots.

Small bubbles are perfectly round. They are held in shape by surface tension. But surface tension is not strong enough to hold bigger bubbles in shape. Big bubbles become flattened or turned into mushroom shapes and may even break up into smaller bubbles as they wobble up to the surface.

绿色植物在太阳照射下释放氧气。当水生植物释放氧气时，就形成了气泡。有时你可在池塘或鱼缸里看到从水草的根茎或叶子上慢慢地冒出一连串的小氧气气泡。大气泡向上冒得快一点。大的甲烷气泡有时会直冲向池塘表面。甲烷，也称沼气，是因植物腐烂在水下形成的。

小气泡是滚圆的。它们受表面张力的作用而保持圆形。但表面张力不够大，不能将个儿大点的气泡保持圆形，这样大气泡就呈扁平状或蘑菇状，甚至会在摇摆着窜向水面时破裂成小个儿的气泡。

Underwater bubbles trapped beneath ice press against its underside, becoming button-shaped. These methane bubbles rose to the surface at intervals as the lake was freezing. During the time between one bubble rising and the next, the ice thickened, causing columns of bubbles to form inside the ice.
被凝固住的水下气泡紧顶着冰层下侧，成了钮扣状。这些甲烷气泡适逢湖水在结冰时不时冒向水面。当气泡一个接一个向上冒时，冰层变厚，从而导致在冰层内形成了气泡柱。

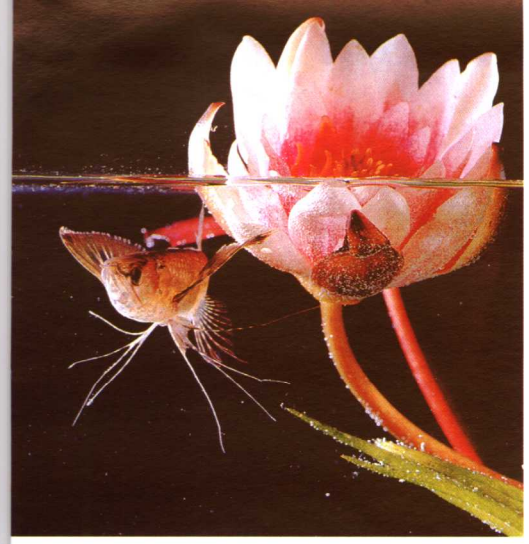


Mud at the bottom of a lake often contains trapped methane gas. The slightest disturbance will cause the gas to bubble up to the surface. As this Avocet walks delicately through the shallow water, it leaves behind a trail of methane bubbles.

湖底的淤泥常含有未冒出来的甲烷气体。稍有轻微的动静就会使这种气体向水面冒出，形成气泡。当这只反嘴鹬小心翼翼地趟过这片浅水滩时，身后冒出一连串的甲烷气泡。

The size of a bubble in water depends on pressure. The greater the pressure, the smaller the bubble. Pressure increases the deeper you go, and, at the bottom of the sea there is huge, crushing pressure due to the weight of water up above. Here, a lot of gas is squeezed into a very little space. A bubble the size of a pea in the ocean depths would swell to the size of a football by the time it reached the surface—if it did not break up into thousands of smaller bubbles on the way.

水中气泡的大小取决于压力。压力越大，气泡越小。水越深，压力越大。海底就因上部水体的重量而存在着千钧重压。大量气体在此处被挤进极小的空间。一个在海洋深处如豌豆大小的气泡，如果在冒向水面时未破裂，没有变成成千上万个小气泡的话，当它到达水面时就会膨胀成足球般大小。



The small bubbles on this waterlily have not come from the plant but from the water itself. They are bubbles of air which dissolved in the water overnight and then came out of solution as the water warmed in the morning.
睡莲上的这些小气泡的产生与睡莲无关，而是由水本身产生的。水中的空气在夜间溶于水，第二天在水温上升后，空气从水中分解出来而形成这些气泡。

Old Faithful, the famous geyser in Yellowstone Park, USA, takes about an hour to build up enough pressure to erupt.
美国黄石公园的著名间歇泉“老实泉”需要大约一个小时的时间才能积聚足够的压力，喷出泉水。

In some parts of the world, the Earth's crust is so thin that water near to the surface is heated to boiling by the hot rocks underneath. This pool of boiling water has steam bubbles rising in its centre.
在世界的某些地方，地壳是如此之薄，靠近地表的水被它底下滚烫的岩石加热至沸腾。这个沸水池中心冒出了蒸汽气泡。

Bubbles sometimes appear in water as if from nowhere. Clear water left standing in a glass may have lots of little bubbles in it after a few minutes. These are bubbles of air that was **dissolved** in the water and has come out of **solution**. The bubbles form on the sides of the glass. Two things cause these bubbles. They form when the water is warmed, because warm water can hold less dissolved air than cold water. They also form when pressure is reduced. For instance, when you turn on a tap, the water that comes out is under less pressure than it was in the pipe—and so bubbles often form in fresh tap water.

The bubbles in boiling water are not air but **steam**. In some parts of the world, water is heated to boiling point by hot rocks deep underground and comes bursting to the surface as a **geyser**. Bubbles of steam in the underground water **expand** because the pressure falls as the water comes rushing upwards, causing it to squirt high into the air.

有时出现在水中的气泡似乎不知从何而来。将清澈的水在玻璃杯里静放几分钟后，就会在水中形成大量的小气泡。溶于水中的空气由于被分解而从液体中释放出来，形成了这些气泡。玻璃杯的杯壁上也会产生气泡。有两种情形会产生气泡：当水受热时会产生，因为热水比凉水能溶解的空气要少；当压力减弱时也会产生。比如，当你打开水龙头，流出来的水受到的压力要比在水管中时少一些——因此在打开水龙头时，水中经常产生气泡。

出现在沸水中的气泡不是空气，而是蒸汽。在世界的某些地方，水被地下深处滚烫的岩石加热至沸点，并以间歇泉的形式喷出地表。地下水中的蒸汽气泡因水向上冲出，造成压力减轻而膨胀，同时导致水在空中喷出很高。

Bubbles Out of Water
水外的气泡

The petals of this Nasturtium have been shredded by large raindrops which came down with such force that they made bubbles on puddles as well.
这朵旱金莲的花瓣被大滴的雨点打落，雨点落下时的力量如此之大，以致于在水坑里也形成了气泡。

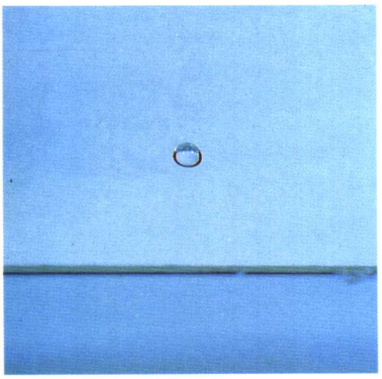
Bubbles that rise in a pond or river usually burst when they get to the surface. Sometimes a bubble will float for a time and then you can see how it is formed from a thin layer of water. A large floating bubble is almost a **hemisphere**. Where its edge sits on the water, surface tension pulling inwards is exactly balanced by gas pressure pushing outwards, keeping the bubble in shape.

Soap or **detergent** added to water makes floating bubbles last longer. Some **polluted** rivers contain detergents, and that is why there are often masses of bubbles floating along on the surface.

在池塘或河流中，向上冒的气泡通常在到达水面时破裂。气泡有时能漂流一段时间，这时，你可观察到它是如何由薄薄一层水形成的。个儿大的漂浮着的气泡几乎是一个半球。在它紧靠水面一侧的地方，向内拖拽的表面张力正好被向外推的气体压力所抵消，使气泡的形状得以保持。

在水中加入肥皂或洗涤剂可使漂浮的气泡保持更长时间。一些被污染的河流含有洗涤剂，这就是河水表面常漂浮着大片大片的气泡的原因。

A large raindrop comes rushing down towards the surface of a pond.
一大滴雨点急速落到池塘水面。



The raindrop smacks into the surface, sending up a circular sheet of water shaped like a crown.
雨点砸向水面，溅起一个皇冠状的圆形水幕。

The force of the raindrop causes a round pit to form in the surface, while the crown-shaped sheet rises higher.
雨滴的力量使水面形成一个圆水坑，而皇冠状的水幕则溅得更高。

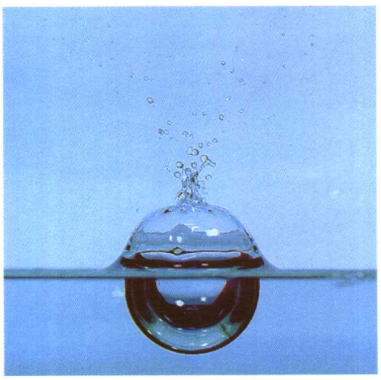
Animals such as worms and shrimps live in burrows on a muddy seashore. Their burrows become filled with air at low tide.
When the tide comes in, this air is forced out, forming large floating bubbles.
诸如蠕虫和虾这样的动物生活在泥泞的海边洞穴里。退潮时洞穴充满空气。当涨潮时，空气被排出洞穴，因此形成大个儿的漂浮气泡。

Detergents reduce surface tension. This means that the pulling force on the surface of bubbles is not so strong, and so they do not burst so easily. That is why it is possible to blow round bubbles that float in the air using water containing a little detergent (*see page 28*).

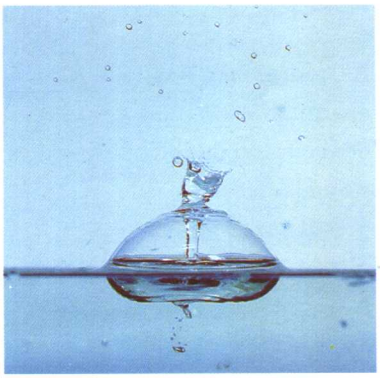
洗涤剂减轻了表面张力。这意味着气泡表面的拉力不那么强大，所以气泡也就不容易破裂。这就是为什么可以用含有一点洗涤剂的水吹出漂浮在空气中的圆气泡。*(见第28页)*

Surface tension acts like a draw-string and begins to pull the top of the crown-shaped sheet inwards.
表面张力的作用像一根拉绳，开始将皇冠状水幕的顶部向内拉。

The top of the crown is pulled together by the surface tension, forming a bubble, part of which is the pit in the water's surface.
皇冠状水幕的顶部被表面张力拉拽，成了一个气泡，气泡的一部分是水面的坑。



As the effect of the drop's force wears off, water at the bottom of the pit rushes upwards, forming a column which shoots up through the top of the bubble.
随着雨滴下落力量的减弱，水坑底部的水向上冲，形成水柱，冲出气泡顶部。



Breathing Bubbles
用于呼吸的气泡

A Water Spider keeps a silvery-looking supply of air trapped amongst the hairs of its body so that it can breathe when it is under water. It also spins an underwater bell of silk. The spider brings air down to its **diving bell** until it is filled with a large bubble. This makes a safe place for the air-breathing spider to rest while it is waiting for prey.

水蜘蛛在其身体毛发中，携有一个银色的空气补给气泡，以便在水下呼吸用。它还吐丝，织成一个水下丝钟。蜘蛛将空气注入它的潜水钟，直至潜水钟被大气泡充满。这就为呼吸空气的蜘蛛在等待捕获猎物时提供了一个安全的地方。

Water animals that breathe air have to keep coming to the surface. It can be dangerous for small creatures to do this often and so many carry a bubble of air with them. Some water beetles keep air under their **elytra**, or wing cases. Others have hairs on their undersides which hold a bubble of air, making them look silvery underneath. These beetles can stay under water for many minutes, or even hours, using their breathing bubbles. Other animals, such as newts and frogs, come to the surface to gulp air into their lungs before diving. They just hold their breath while they are under water.

Some animals that breathe water come onto land occasionally. They have to bring with them enough water to keep their **gills** wet. Crabs that come on to land take in some air to supply the water around their gills with oxygen. When they blow this air out, it often forms bubbles (*see pages 1 and 26*).

呼吸空气的水生动物，必须不断地到水面吸气。经常这么做对小动物来说是危险的，因此许多动物身上带着一个充满空气的气泡。一些水生甲虫在鞘翅下携有空气，其他则在身体下侧的毛发中带有气泡，使其下部看起来银光闪闪。这些甲虫靠气泡呼吸，能在水下呆好几分钟，甚至好几个小时。其它动物比如蝾螈和青蛙跳入水中之前，要到水面上大口呼吸空气。在水下，它们只能屏住呼吸。

一些通过水呼吸的动物不时到陆地上来。它们为使鳃保持湿润，不得不随身携带足够的水。爬上陆地的螃蟹吸进一些空气，为其鳃周围的水提供氧气。当它们呼出这些空气时，经常形成气泡。*(见第1页和第25页)*

A Great Diving Beetle is an air-breather. It takes a supply of air stored under its elytra when it dives.

大龙虱是呼吸空气的。当它潜入水中时，带着贮存在鞘翅下的空气补给。

Dolphins are air-breathing mammals. This one has just come to the surface of the sea to breathe. Its nostril, or blowhole, is wide open to take in air.
海豚是呼吸空气的哺乳动物。这只海豚刚游到海面上呼吸，它的鼻孔，或称气孔，充分张开以吸进空气。

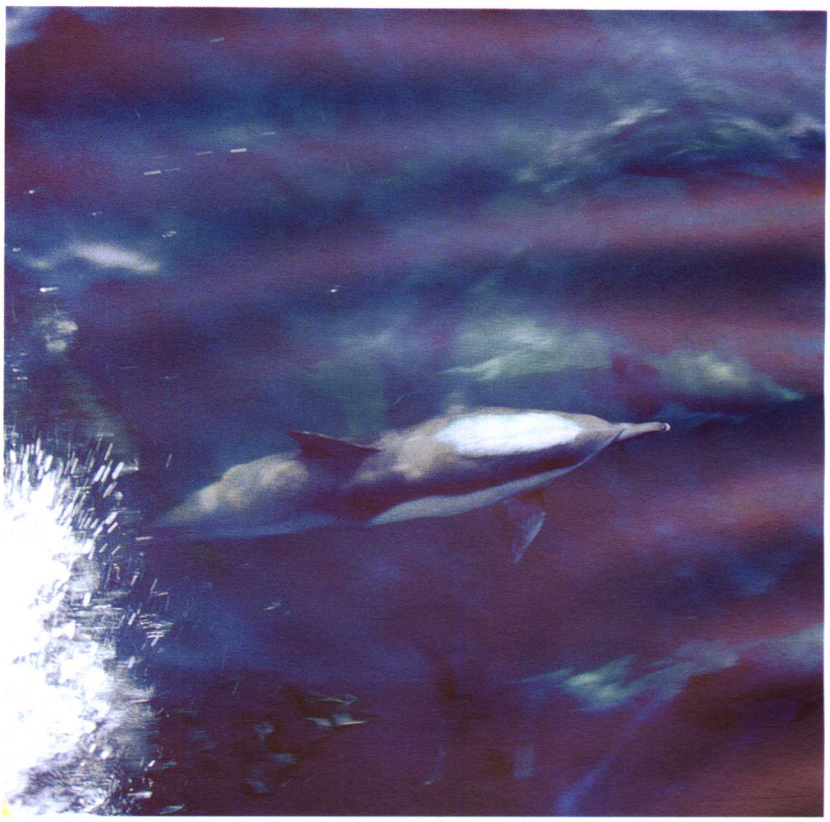
Just before a dolphin surfaces, it empties its lungs of stale air. The air bursts out of its blowhole as a stream of bubbles.
海豚就在浮出水面之前，将肺中的废气排出。空气从气孔中喷出，形成一连串的气泡。

Whales and dolphins come to the surface regularly to take deep breaths so that they can store large amounts of oxygen in their blood and muscles. They breathe out again before they dive, but still take some air with them. Underwater, dolphins talk to each other in squeaks. When they squeak, a thin stream of bubbles sometimes comes out of the dolphin's **blowhole**.

Humpback Whales use streams of bubbles to round up fish. A group of whales swims around in a circle below a shoal of fish and each whale lets out a stream of bubbles. As the bubbles rise, they form a circular curtain through which the fish do not like to swim. Suddenly, the whales rush up from the depths and gulp down the fish!

鲸鱼和海豚定期到水面深呼吸，以便在血液和肌肉里储存大量的氧气。潜水前再呼出空气，但仍携带一部分空气潜水。海豚在水下发出吱吱的声音，互相交谈。当它们吱吱地交谈时，有时会有一串细长的气泡从海豚气孔中喷出。

座头鲸用气泡柱来围捕鱼。一群鲸鱼在一大群鱼的下面围成一圈，每条鲸鱼都喷出一串气泡柱。气泡升起形成了一个鱼游不出去的圆形水帘。这时，鲸鱼会突然从海水深处冲上来，将鱼大口吞下！



Humans cannot hold their breath for more than two or three minutes at the very most, and so divers have to take an air supply with them. A diver working in deep water breathes air at high pressure. The pressure causes **nitrogen** gas to dissolve in the diver's blood. When the diver comes up and the pressure is released, little bubbles of nitrogen may form in the blood, causing a painful—and sometimes fatal—condition called **diver's bends**. A whale does not suffer from the bends because it does not breathe while it is under water. It simply holds its breath.

人类屏住呼吸最多只能坚持两到三分钟，因此潜水员必须携带氧气补给。在深海里工作的潜水员在高压下呼吸空气。压力造成氮气溶解于潜水员的血液中。当潜水员浮出水面时，压力消失，血液中形成氮气小气泡，导致一种令人痛苦的——甚至丧命的病态，即潜函病。鲸鱼不会得潜函病，因为它不在水下呼吸。鲸鱼屏息时间可达半小时之久。

Whales take several deep breaths before they dive. This makes sure that their blood is well supplied with oxygen while they are feeding underwater. At each breath, a cloud of spray and condensation rises into the air. Here, two whales are spouting close together.
鲸鱼在潜水之前要深呼吸几次，这是为了确保它们在水下进食时血液里有足够的氧气供给。每一次呼吸喷出的水雾及冷凝成的水滴在空中喷出老高。这里有两条鲸鱼紧靠在一起喷水。