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Volume 2

MICROPÆDIA

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Ready Reference

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# How to use the MICROPAEDIA

The 12 volumes of the MICROPAEDIA contain tens of thousands of shorter articles on specific persons, places, things, and ideas, arranged in alphabetical order. The MICROPAEDIA can be used as an information resource on its own; and it can function as support for the longer articles in the MACROPAEDIA (to which it refers whenever appropriate). The MICROPAEDIA in turn is supported by references in the INDEX and by the lists of suggested readings in the PROPAEDIA. Finally, the MICROPAEDIA is the portion of the *Encyclopædia Britannica* best suited for the reader who wishes to browse among the countless subjects in all fields of human learning and history in all times and places.

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## Alphabetization

Entry titles are alphabetized according to the English alphabet, A to Z. All diacritical marks (such as in ö, ð, or ñ) and foreign letters without parallels in English (such as ayin [ʾ] and hamza [ʔ]) are ignored in the alphabetization. Apostrophes likewise are ignored. Titles beginning with numbers, such as **1812, War of**, are alphabetized as if the numbers were written out (**Eighteen-twelve, War of**).

Alphabetization proceeds according to the “word-by-word” principle. Thus, **Mount Vernon** precedes **mountain**; any **John** entry precedes **John Henry**, which in turn precedes **Johne’s disease**. Any character or string of characters preceding a space, hyphen, or dash is treated as a word and alphabetized accordingly. Thus, **De Broglie** precedes **debenture**, and **jack-o’-lantern** precedes **jackal**. Titles with identical spellings are arranged in the following order: (1) persons, (2) places, (3) things.

For many rulers and titled nobility, chronological order, as well as alphabetical order, governs placement. Rulers of the same given name (*e.g.*, **William**) may be grouped together, separate from other entries, and indicated by the symbol •. They may be subgrouped alphabetically by country and, within each country, arranged chronologically (**William I, William II**, etc.). Nobility or peers of the same titled name (*e.g.*, **Essex, EARLS OF**) are similarly grouped together, separate from other entries; they are indicated by the symbol • and arranged chronologically.

Places with identical names are arranged in the alphabetical order of the countries where they are located. Identical place-names in the same country are alphabetized according to the alphabetical order of the state, province, or other political subdivision where they are found.

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## Entry arrangement

The titles of entries are arranged according to the forms commonly found in indexes and dictionaries, with some special conventions.

Entry titles for certain physical features, institutions, structures, events, and concepts are ordinarily inverted to place the substantive word first. Thus, the Bay of Bengal is entered as **Bengal, Bay of**; the Bank of England as **England, Bank of**; the Tower of London as **London, Tower of**; the Siege of Vienna as **Vienna, Siege of**; and the balance of power as **power, balance of**. If the name of a physical feature, institution, structure, event, or concept has two or more descriptors, it is entered under the descriptor appearing first. Thus, the Episcopal Church in Scotland is entered as **Episcopal Church in Scotland** (not **Scotland, Episcopal Church in**); the Leaning Tower of Pisa as **Leaning Tower of Pisa**; and the kinetic theory of gases as **kinetic theory of gases**.

The entries for most Western persons are arranged so that one can read a name in correct order by beginning after the first comma, proceeding to the end of the boldface type, returning to the beginning word or words, and proceeding forward to the first comma. Thus, the entry **March, Patrick Dunbar, 2nd Earl of**, is read “Patrick Dunbar, 2nd Earl of March”; the entry **Orléans, Louis, duc d’**, is read “Louis, duc d’Orléans.” Names of Far Eastern origin are given in Oriental order, with the surname preceding the personal name (*e.g.*, **Tōjō Hideki, Deng Xiaoping, Nguyen Cao Ky**).

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## Cross-references

Some cross-reference entries appear in the MICROPAEDIA for the purpose of leading a reader from names that are familiar to alternate names that may not be. Cross-references also appear frequently within or at the ends of standard entries, where they are identified by *see*, *see also*, *see under*, *q.v.* (*quod vide*, “which see”), or *qq.v.* (*quae vide*, “which see,” plural).

Certain entries serve both as relatively brief essays on general subjects and as cross-references to the same subjects treated at greater length and in greater depth in the MACROPAEDIA. Such an entry (*e.g.*, **igneous rock**) begins with a definition of the subject and then provides the following cross-reference: “A brief treatment of igneous rocks follows. For full treatment, *see* MACROPAEDIA: Minerals and Rocks.”

Entries on certain broad subjects (*e.g.*, **music**) direct the reader to several relevant articles in the MACROPAEDIA and also to the PROPAEDIA for listings of related articles in the MICROPAEDIA.

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## Abbreviations

Abbreviations used in the MICROPAEDIA are given in a list that appears at the end of every MICROPAEDIA volume.

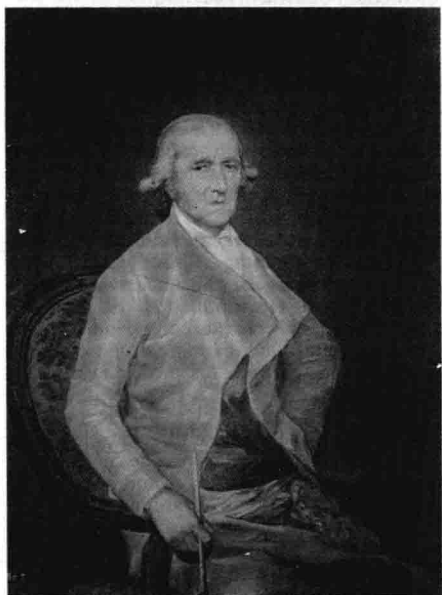
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## Territorial boundaries

In articles and maps indicating disputed geopolitical boundaries and territories, the attribution of sovereignty or administrative subordination to any specific area does not imply recognition of the status claimed by an administering power.



**Bayeux, Francisco**, in full FRANCISCO BAYEU Y SUBÍAS (b. March 9, 1734, Zaragoza, Spain—d. Aug. 4, 1795, Madrid), painter, the brother-



"The Painter Francisco Bayeu," oil painting by Francisco de Goya; in the Prado, Madrid

SCALA—Art Resource

in-law of Francisco de Goya and court painter to King Charles III of Spain. Considered by his contemporaries to be the finest Spanish painter of the period, he was greatly influenced by Anton Raphael Mengs and the Italian Giovanni Battista Tiepolo, both painters at the court of Charles.

After studying in Zaragoza under José Luzán Martínez and in Madrid under Antonio González Velázquez, Bayeu was called by Mengs to assist in the decoration of the royal palace in 1763. He created frescoes for the Cathedral of El Pilar in Zaragoza, the Toledo Cathedral, and the royal palaces in Madrid, El Pardo, La Granja, and Aranjuez. Bayeu's mature style was a mixture of French Rococo and the academic classicism of Mengs. Although his drawings, hundreds of which have been preserved, are beautifully animated, his finished frescoes have an academic stiffness. His brothers Ramon and Manuel were also painters.

**Bayeux**, town, Calvados *département*, Basse-Normandie *région*, northwestern France, on the Aure River, northwest of Caen. As Bajocasses, it was a capital of the Gauls, then, as Augustodurum and, later, Civitas Baiocassium, it was an important Roman city that became a bishopric in the 4th century. Cap-



The Gothic cathedral, Bayeux, Fr.

Club Iris

tured in 880 by Rollo the Viking, it became a Norman stronghold. While Rouen was completely Gallicized, Bayeux remained Norse-speaking. During the quarrels between the sons of William I the Conqueror, Henry I of England pillaged the town in 1106. Bayeux was besieged and taken on several occasions during the Hundred Years' War and the 16th-century Wars of Religion. Occupied by the Germans in June 1940, it was the first town liberated by the Allies (June 7, 1944) and the first to receive General Charles de Gaulle (June 14) on his promised return to France.

A bypass encloses the town, which is in part modern and in part medieval, with half-timbered houses and cobbled streets. Its Gothic cathedral, mainly 13th century, has an 11th-century crypt. The Bishop's Palace (11th–14th century) now serves as the *hôtel de ville*, law courts, and art gallery. The renowned Bayeux Tapestry, telling the story of the Norman Conquest of England, is displayed in the palace in the Museum of the Tapestry of Queen Matilda (Bayeux Museum), a vast room especially designed for it.

Bayeux processes dairy foods and manufactures lace and plastics. Pop. (1990) 14,704.

**Bayeux Tapestry**, medieval embroidery depicting the Norman Conquest of England in 1066, remarkable as a work of art and important as a source for 11th-century history.



English axman in combat with Norman cavalry during the Battle of Hastings, detail from the Bayeux Tapestry; in the Musée de la Tapisserie de la Reine-Mathilde, in the former Bishop's Palace, Bayeux, Fr.

Giraudon—Art Resource

The tapestry is a band of linen 231 feet (70 m) long and 19.5 inches (49.5 cm) wide, now light brown with age, on which are embroidered, in worsteds of eight colours, more than 70 scenes representing the Norman Conquest. The story begins with a prelude to Harold's visit to Bosham on his way to Normandy (1064?) and ends with the flight of Harold's English forces from Hastings (October 1066); originally, the story may have been taken further, but the end of the strip has perished. Along the top and the bottom run decorative borders with figures of animals, scenes from the fables of Aesop and Phaedrus, scenes from husbandry and the chase, and occasionally scenes related to the main pictorial narrative. It has been restored more than once, and in some details the restorations are of doubtful authority.

When first referred to (1476), the tapestry was used once a year to decorate the nave of Bayeux Cathedral in France. There it was "discovered" by the French antiquarian and scholar Bernard de Montfaucon, who published the earliest complete reproduction of it in 1730. Having twice narrowly escaped destruction during the French Revolution, it was exhibited in Paris at Napoleon's wish in 1803–04 and thereafter was in civil custody at

Bayeux, except in 1871 (during the Franco-German War) and from September 1939 to March 1945 (during World War II).

Montfaucon found at Bayeux a tradition, possibly not more than a century old, that assigned the tapestry to Matilda, wife of William I the Conqueror, but there is nothing else to connect the work with her. It may have been commissioned by William's half brother Odo, bishop of Bayeux; Odo is prominent in the later scenes, and three of the very few named figures on the tapestry have names borne by obscure men known to have been associated with him. This conjecture would date the work not later than about 1092, an approximate time now generally accepted. The tapestry has affinities with other English works of the 11th century, and, though its origin in England is not proved, there is a circumstantial case for such an origin.

The tapestry is of greater interest as a work of art. It is also important evidence for the history of the Norman Conquest, especially for Harold's relation to William before 1066; its story of events seems straightforward and convincing, despite some obscurities. The decorative borders have value for the study of medieval fables. The tapestry's contribution

to knowledge of everyday life about 1100 is of little importance, except for military equipment and tactics.

**Bayezid**, also spelled BAYAZID, name of Ottoman sultans grouped below chronologically and indicated by the symbol ●.

● **Bayezid I**, byname YILDIRIM (The Thunderbolt) (b. c. 1360—d. March 1403, Akşehir, Ottoman Empire), Ottoman sultan in 1389–1402 who founded the first centralized Ottoman state based on traditional Turkish and Muslim institutions and who stressed the need to extend Ottoman dominion in Anatolia.

In the early years of Bayezid's reign, Ottoman forces conducted campaigns that succeeded in controlling vast Balkan territories. Later, Venetian advances in Greece, Albania, and Byzantium and the extension of Hungarian influence in Walachia and Danubian Bulgaria compelled Bayezid to blockade Constantinople (1391–98), to occupy Tirnova, in what is now Bulgaria (July 1393), and to conquer Salonika (April 1394). His invasion of Hungary in 1395 resulted in a Hungarian-Venetian crusade against the Ottomans. Bayezid inflicted a crushing defeat on the crusaders at Nicopolis (Sept. 25, 1396).

To build a strong Islāmic and Turkish base for his domain, Bayezid began to widen Ottoman suzerainty over the Turkish-Muslim rulers in Anatolia. He annexed various Turkmen emirates in Anatolia and defeated the Karaman emirate at Akçay (1397). These conquests brought Bayezid into conflict with the Central Asian conqueror Timur (Tamerlane), who claimed suzerainty over the Anatolian Turkmen rulers and offered refuge to those expelled by Bayezid. In a confrontation between Bayezid and Timur in Çubukovası near Ankara (July 1402), Bayezid was defeated; he died in captivity.

• **Bayezid II**, byname **BAYEZID THE JUST**, Turkish **BAYEZİD ADLİ** (b. December 1447/January 1448?, Demotika, Thrace, Ottoman Empire—d. May 26, 1512, Demotika), Ottoman sultan (1481–1512) who consolidated Ottoman rule in the Balkans, Anatolia, and the eastern Mediterranean and successfully opposed the Šafavid dynasty of Persia.

Bayezid II was the elder son of the sultan Mehmed II, the conqueror of Constantinople. On the death of his father in 1481, his brother Cem contested the succession. Bayezid, supported by a strong faction of court officials at Constantinople, succeeded in taking the throne. Cem eventually sought refuge with the Knights of Saint John at Rhodes and remained a captive until his death in 1495.

Under the new reign an immediate reaction set in against some of the policies of Mehmed II. Influenced by the *‘ulamā*, interpreters of the law of Islām, and by the great officials aligned with them, Bayezid restored the Muslim properties dedicated to religious and charitable purposes that Sultan Mehmed had taken over for the state. Bayezid also rejected his father's marked pro-European orientation by such acts as removing from the imperial palace the paintings that Italian artists had executed for Mehmed II.

At the same time, Bayezid II continued the territorial consolidation that his father had begun. Hercegovina, in the Balkans, was brought under direct Ottoman control in 1483. The occupation, in 1484, of two fortresses on the estuaries of the Danube and the Dniester rivers strengthened the hold of the Ottomans over the land route to the Crimea, where

the khan of the Crimean Tatars had been, in name at least, a vassal of the sultan since 1475. The war of 1499–1503 directed against the Venetian empire in the Levant and in the Balkans carried the process of consolidation still further. It resulted in the Ottoman conquest of Venetian strongholds in Morea (Peloponnesus) and on the Adriatic shore—a triumph amply justifying the program of naval construction that Bayezid had approved in the years before the beginning of the war.

With the expansion of his rule over much of Anatolia, Bayezid had earlier come into conflict with the Mamlūk sultanate of Egypt and Syria, each side striving to dominate the ill-defined border zones dividing them and to maintain under effective control the small principalities established there. While a Turkish fleet had sufficed to dismantle a large part of Venice's empire, Bayezid, fearing that an alliance of Christian powers using his brother Cem might be formed against him, committed only a modest force against the Mamlūks. The long land war ended in a stalemate.

More formidable still was the situation that arose in the lands to the east of Anatolia. In 1499 the adherents of the Šafavids, a heretical order of Islām, had set out to establish in Persia a powerful regime under their master Ismā‘il I. The religious teaching of the Šafavids had met with great success among the nomadic Turkmen tribes of Anatolia, whose warriors formed the main element in the armies of Shah Ismā‘il (or Esmā‘il). It was evident that the propaganda of the Šafavids, if allowed to continue without hindrance, might well undermine Ottoman rule within the Asian lands. The danger was underlined in 1511, when the adherents of the shah rose in rebellion against the Ottomans in Anatolia.

At this same time a dispute over the succession broke out between Bayezid's sons. One of them, Selim, the governor of Trebizond, went to the Crimea in 1511, secured aid there from the Tatar khan, and then crossed the Danube into the Balkans. Defeated in battle against Bayezid, Selim fled to the Crimea. Meanwhile, the Šafavid rebellion had been put down; and Ahmed, another son, who had shared in the victory, marched toward Constantinople. Failing to gain the support of the Janissaries (elite military guards), he turned back to bring most of Anatolia under his control. Bayezid, fearing that Ahmed might seek assistance from Shah Ismā‘il and unable to resist pressures from some of his advisers and from the corps of Janissaries, who favoured Selim, recalled Selim from the Crimea and abdicated (April 1512) in his favour. Bayezid died the following month.

Bayezid II was a pious Muslim, strict in his observance of the precepts of the Qur‘ān and the Islāmic law. During his reign, much of the state revenue was devoted to the building of mosques, colleges, hospitals, and bridges. He also supported jurists, scholars, and poets, both within and outside the Ottoman Empire. In temperament “molto melanconico, superstizioso e ostinato” (“very melancholic, superstitious, and stubborn”), in the words (1503) of the Venetian ambassador, Bayezid was interested in philosophical and cosmographical studies.

(V.J.P.)  
BIBLIOGRAPHY. Sidney Nettleton Fisher, *The Foreign Relations of Turkey, 1481–1512* (1948), is a most useful monograph based extensively on Venetian source materials. Dorothy M. Vaughan, *Europe and the Turk: A Pattern of Alliances, 1350–1700* (1954, reprinted 1976); and M.A. Cook (ed.), *A History of the Ottoman Empire to 1730* (1976), serve to illustrate the contemporary attitude of historical scholarship toward Bayezid II. The article “Bayazid II,” in *The Encyclopaedia of Islam*, new ed. (1960), the standard work of reference for Orientalist scholars, includes a bibliography.

**Bayinnaung**, also called **BRAGINOCO** (fl. late 16th century), king of the Toungoo dynasty (reigned 1551–81) in Myanmar (Burma). He

unified his country and conquered the Shan States and Siam (now Thailand), making Myanmar the most powerful kingdom in mainland Southeast Asia.

In 1550 a revolt broke out among the Mons of southern Myanmar, and Bayinnaung's brother-in-law, Tabinshwehti, was assassinated at Pegu in 1551 by a Mon prince. Bayinnaung marched to Toungoo, eliminated a pretender to the throne, and proclaimed himself king; then he marched south, captured the city of Pegu, and executed the rebel leader, Smin Htaw. The other Mon rulers then surrendered, and the revolt was at an end. Bayinnaung made Pegu his capital, as Tabinshwehti had.

In 1554 Bayinnaung set out against Shan chiefs, who occupied the ancient Myanmar capital of Ava. He captured it the following year. The Shans were placed under Myanmar suzerainty, and Bayinnaung was consequently in a position to attack his most powerful enemy, Siam.

In 1563 Bayinnaung took as a pretext for war the refusal of the Siamese to acknowledge his suzerainty. The following year he captured the Siamese capital of Ayutthaya and brought the Siamese royal family to Myanmar as hostages. In 1568, when a revolt flared up, Bayinnaung again invaded Siam. Because the Siamese put up fierce resistance, Ayutthaya was not captured until August 1569. The Myanmar king installed a new vassal on the throne and deported thousands of Siamese into Myanmar as slaves. The Myanmar dominated Siam for more than 15 years; they were expelled by a liberation movement led by a Siamese prince, Naresuan (reigned 1590–1605).

Bayinnaung was a patron of Buddhism; he built pagodas, gave generous donations to monasteries, and maintained extensive diplomatic relations with the Buddhist kingdom of Ceylon. When Pegu was burned in a Mon revolt in 1564, he rebuilt it on an even grander scale, making one of the richest cities in Southeast Asia.

**Baykalskoye Ozero** (Siberia): see Baikal, Lake.

**Bayle, Pierre** (b. Nov. 18, 1647, Carla-le-Comte, Fr.—d. Dec. 28, 1706, Rotterdam, Neth.), philosopher whose *Dictionnaire historique et critique* (1697; “Historical and Critical Dictionary”) was roundly condemned by the French Reformed Church of Rotterdam and by the French Roman Catholic church because of its numerous annotations deliberately designed to destroy orthodox Christian beliefs.

Bayle was the son of a Calvinist minister and briefly embraced Roman Catholicism in 1669. He acted as tutor, then taught philosophy (1675–81) at the Protestant Academy of Sedan. After moving to Rotterdam in 1681 to teach philosophy and history, he published (1682) his anonymous reflections on the comet of 1680, deriding the superstition that comets presage catastrophe. He also questioned many Christian traditions, thus arousing the ire of a Calvinist colleague, Pierre Jurieu. Bayle's plea for religious toleration (even for atheists) eventually convinced Jurieu that Bayle was an atheist in disguise. The rift between the two was complete when Bayle advocated a conciliatory attitude toward the anti-Calvinist government of Louis XIV; in 1693 Bayle was deprived of his Rotterdam professorship.

Thereafter, Bayle devoted himself to his famous *Dictionnaire*, ostensibly a supplement to Louis Moreri's dictionary but in fact a work of considerable originality. In this encyclopaedic work the articles themselves—on religion, philosophy, and history—are little more than summary expositions. The bulk of the *Dictionnaire* consists of quotations, anecdotes, commentaries, and erudite annotations that cleverly undo whatever orthodoxy the articles contain. Vehement objections were voiced, particularly to the article “David,” to



Bayezid II, miniature by an unknown Ottoman artist, c. 1580; in the Topkapı Saray Museum, Istanbul

By courtesy of the Topkapı Saray Museum, Istanbul



the bias in favour of Pyrrhonic (radical) skepticism, atheism, and epicureanism, and to the use of Scripture to introduce indecencies. This oblique method of subversive criticism was adopted by 18th-century encyclopaedists.

Bayle was convinced that philosophical reasoning led to universal skepticism, but that nature compelled man to accept blind faith, an extremely popular view in the early 18th century. Bayle's last years were troubled by allegations that he was conspiring with France to detach the Dutch from their Anglo-Austrian alliance. On his death, however, foe and friend alike lamented the passing of a great intellectual.

**BIBLIOGRAPHY.** Jean Delvolve, *Religion, critique, et philosophie positive chez Pierre Bayle* (1906); Howard Robinson, *Bayle the Skeptic* (1931).

**Baylebridge, William**, pseudonym of CHARLES WILLIAM BLOCKSIDE (b. Dec. 12, 1883, Brisbane, Queen., Australia—d. May 7, 1942, Sydney), poet and short-story writer considered one of the leading writers of Australia in his day.

The son of an auctioneer, he was educated in Brisbane, then at the age of 25 went to England, where he published his first booklet of verse, *Songs o' the South* (1908). He also travelled to France and Egypt. He returned to Australia in 1919 and published more than 20 books and booklets of verse in private, limited editions.

His work leans heavily on Elizabethan and German models. The best known volumes of his verse are *Love Redeemed* (1934) and *This Vital Flesh* (1939); some excellent short stories about World War I were collected in *Anzac Muster* (1921).

**Baylis, Lilian Mary** (b. May 9, 1874, London—d. Nov. 25, 1937, London), theatrical manager and founder of the Old Vic as a centre of Shakespearean productions.

Baylis received a musical education, appeared as a child prodigy in London, and went with



Lilian Baylis

By courtesy of the Mander and Mitchenson Theatre Collection, London

her parents, who were singers, to South Africa in 1890. She returned to England in 1898 to assist her aunt, Emma Cons, who had turned the Royal Victoria Theatre into a temperance hall under the name of the Royal Victoria Coffee Music Hall. Taking complete control in 1912, Lilian Baylis created the Old Vic, world famous as the home of Shakespearean production, and in 1931 took over the derelict Sadler's Wells Theatre and made it a centre of opera and ballet; its company became, in 1956, the Royal Ballet. Lilian Baylis was created a companion of honour in 1929.

**Bayliss, Sir William Maddock** (b. May 2, 1860, Wolverhampton, Staffordshire, Eng.—d. Aug. 27, 1924, London), British physiologist, co-discoverer (with the British physiologist Ernest Starling) of hormones; he conducted pioneer research in major areas of physiology, biochemistry, and physical chemistry.

Bayliss studied at University College, London, and Wadham College, Oxford. He began a long and profitable collaboration with

Starling soon after he obtained a teaching post at University College, London (1888), where he became professor of general physiology (1912–24). Their study in the 1890s of nerve-controlled contraction and dilation of blood vessels resulted in the development of an improved hemopiezometer (a device for measuring blood pressure). Observation of intestinal movements led to their discovery of the peristaltic wave, a rhythmic contraction that forces forward the contents of the intestine.

Bayliss and Starling are best known, however, for determining, in 1902, the chemical substance that stimulates the secretion of pancreatic digestive juices—the first example of hormonal action. In a famous experiment performed on anesthetized dogs, they showed that dilute hydrochloric acid, mixed with partially digested food, activates a chemical substance in the epithelial cells of the duodenum. They found that this activated substance, which they called secretin, released into the bloodstream, comes into contact with the pancreas, where it stimulates secretion of digestive juice into the intestine through the pancreatic duct. They coined the term hormone (Greek *horman*, “to set in motion”) to describe specific chemicals, such as secretin, that stimulate an organ at a distance from the chemical's site of origin.

Bayliss went on to demonstrate how the enzyme trypsin was formed from inactive trypsinogen in the small intestine and to measure precisely the time required for a trypsin solution to digest specific quantities of protein.

Bayliss' World War I investigation of wound shock led him to recommend gum-saline injections that were responsible for saving many lives. He wrote *The Nature of Enzyme Action* (1908) and *The Vaso-Motor System* (1923); his best known work is *Principles of General Physiology* (1915), considered to be the best text on the subject at that time. He was knighted in 1922.

**Baylor, Elgin** (b. Sept. 16, 1934, Washington, D.C.), U.S. professional basketball player (6 ft 5 in.) who is regarded as one of the game's greatest forwards.

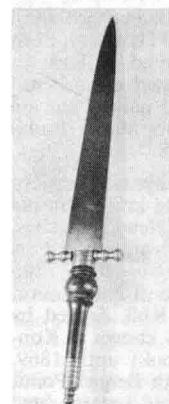
Baylor was an All-American (1958) at Seattle University (1955–58). He signed with the National Basketball Association (NBA) Lakers (Minneapolis and, later, Los Angeles) in 1958 and played for them until his retirement in 1971. During his 14-year career he had a game point average of 27.4, with a 38.2 average in the 1961–62 season. His 71 points in a 1960 game was an NBA record until broken by Wilt Chamberlain's 100 (1962). Baylor was elected to the Basketball Hall of Fame in 1976.

**Baynes, Thomas Spencer** (b. March 24, 1823, Wellington, Somerset, Eng.—d. May 31, 1887, London), man of letters who was editor of the ninth edition of *Encyclopædia Britannica* up to and including the 11th volume and who thereafter continued the work in partnership with William Robertson Smith. Bold and progressive in his planning of the edition, Baynes used his reputation as a scholar to persuade authors of “brilliance and character” to contribute. He himself wrote the *Britannica* article on Shakespeare.

**bayonet**, short, sharp-edged, sometimes pointed weapon, designed for attachment to the muzzle of a firearm and developed, according to tradition, in Bayonne, Fr., early in the 17th century. The Maréchal de Puysegur described the earliest bayonets as having a straight, double-edged blade a foot long with a tapering wooden handle, of equal length, that could be inserted into the muzzle of a musket. The new weapon, considerably shortened, spread through Europe and supplanted the pike.

The plug bayonet, as this first type was called, had some serious defects; once it was inserted into the muzzle, the gun could not be fired, and if driven in too tightly, it could not easily

be removed. Before 1689 a new bayonet was developed with loose rings on the haft to fit around the muzzle. This design was in turn superseded by the socket bayonet that the military engineer Sébastien Le Prestre de Vauban



Plug bayonet, 17th century

By courtesy of the West Point Museum Collections, United States Military Academy

introduced into the French Army in 1688. Vauban's bayonet had a sleeve that slipped over the muzzle and was held in place by a stud on the barrel that locked in a right-angled slot in the socket. The blade was normally triangular in cross section. With minor alterations, Vauban's socket bayonet remained the basic form. In the 19th century some were equipped with saw teeth and could be used as engineering tools. Others were designed for use as entrenching tools.

The development of repeating firearms greatly reduced the combat value of the bayonet. Nevertheless, it was retained through World Wars I and II, though shortened into an all-purpose knife, equipped with a hand grip and carried in a scabbard when not affixed to a rifle.

**Bayonne**, town, Pyrénées-Atlantiques *département*, Aquitaine region, southwestern France, at the confluence of the Nive with the Adour River, 5 mi (8 km) from its mouth. With Biarritz, the noted Atlantic resort, it forms an urban concentration. As Lapurdum, it was the chief port of Roman Novempopulania, and the coastal zone is still called the Pays de Labourd. The present name is thought to be Basque in origin. Traditionally it was the Bayonne Basques who first used the bayonet. Grand Bayonne on the left bank of the Nive, behind fortifications designed by the 17th-century French military engineer Sébastien Le Prestre de Vauban, contains the Château Vieux and the Cathédral de Sainte-Marie (13th–16th century, with two 19th-century



Bayonne, Fr., and the Nive River with the Cathédral de Sainte-Marie

Club Iris

towers [210 ft; 64 m]. Across the river in Petit Bayonne are the Château Neuf, the arsenal, and the Musée Basque. Downstream, on the right bank of the Adour, are the port and industrial complexes of Le Boucau and Forges. Formerly busy with imports of English coal and Spanish ores, Bayonne languished until oil production was started at Parentis-en-Born and natural gas was discovered at Lacq in the 1950s. There are associated petrochemical industries, and sulfur and natural gas are extracted. It is still a port for tunny (tuna) fishermen. Pop. (1982) 40,088.

**Bayonne**, city, Hudson county, northeastern New Jersey, U.S., on a 3-mi (5-km) peninsula between Newark and Upper New York bays, adjacent to Jersey City and within the Port Authority of New York and New Jersey. Bayonne is connected with Staten Island (south) by a bridge over Kill Van Kull. Settled by Dutch traders in 1646, it was known as Konstable Hoeck (Constable Hook) until 1869, when it was consolidated with Bergen Point, Centerville, and Sallertville and incorporated as Bayonne. Since 1875 it has been a centre for oil refining, and it is the northern terminus for several pipeline systems, including the Big Inch (1,476 mi long) from Longview, Texas. Manufactures include machinery, textiles, and chemicals. It has extensive docks and shipyards and a U.S. Army ocean terminal. Pop. (1990) 61,444.

**bayram** (Islām): see 'īd.

**Bayreuth**, city, Bavaria *Land* (state), east-central Germany, on the Roter (Red) Main River between the Fichtelgebirge (mountainous plateau) and the Franconian Jura, north-east of Nürnberg.

First mentioned in 1194, it developed around a castle of the counts of Andechs-Meran and occupied a strategic position at the intersection of several trade routes. After the house of Andechs-Meran died out, Bayreuth passed to the Hohenzollerns in 1248 and became an important centre of the Upper Franconia region. In 1603 the city became the residence of the margraves, who actively patronized the arts and were responsible for many fine Baroque buildings. The reign of the margrave Frederick and his wife, Wilhelmina, the sister of Frederick the Great, was a particularly rich period (1735–63). The New Palace, the old opera house, and parts of the Hermitage (Eremitage) date from that era. Bayreuth was ceded to Prussia in 1791 and passed to Bavaria in 1810.

The city is best known for its association with the composer Richard Wagner. He settled there in 1872, and the foundation stone of the Festival Theatre (Festspielhaus) was laid that same year. It opened in 1876 with the premiere performance of the *Ring of the Nibelungen* cycle. After Wagner's death in 1883, the festivals were carried on by his wife, Cosima, his son Siegfried, and, since 1951, his grandsons Wolfgang and Wieland. The composer's home, villa Wahnfried, has been preserved; the graves of the composer and his wife are in the garden. The composer Franz Liszt and the writer Jean Paul Friedrich Richter are also buried in Bayreuth. The annual music festivals, held in July and August, are a significant factor in Bayreuth's economy.

The University of Bayreuth opened in 1975, and the city is also the site of two education faculties of the University of Erlangen-Nürnberg. Manufactures include machinery, textiles, chemicals, pianos, porcelain, and glassware. Pop. (1989 est.) 70,933.

**Bayrisches Meer** (Germany): see Chiemsee.

**Bayrūt**, *muḥāfaz̤ah* (governorate), nearly co-terminous with Beirut city (its administrative

centre), west central Lebanon, fronting the Mediterranean Sea to the west and north. It consists of part of the coastal plain at the foot of the Lebanon Mountains. It borders Jabal Lubnān *muḥāfaz̤ah* to the east and south. The governorate has an area of 26 sq mi (67 sq km) and grows citrus fruit, bananas, and vegetables. Its traditional role as the hub and cosmopolis of the Middle East was shattered by the Lebanese civil war. Major economic activities were centred on trade, banking, and tourism. In addition to Beirut city, Byblos (Jubayl) is a major town. Pop. (1970 est.) 475,000.

**Bayrūt** (Lebanon) see Beirut.

**Bayśān** (Israel): see Bet She'an.

**Bayt al-Muqaddas** (Israel): see Jerusalem.

**Bayt Lahm** (Israeli-occupied Jordan): see Bethlehem.

**Bayt Mirsham, Tall** (Jordan): see Kiriathsepher.

**Baytown**, city, Harris county, southeastern Texas, U.S., on Galveston Bay, 22 mi (35 km) east of Houston. The area was settled in 1822; in 1864 a Confederate shipyard was built at Goose Creek. The unincorporated community of Baytown was annexed by Pelly (incorporated 1920) in 1945; in 1948 Pelly and Goose Creek (incorporated 1919) were consolidated to form the present city of Baytown. Oil (discovered locally in 1916) is shipped from docks on the Houston Ship Channel at Baytown, which has oil refineries, petrochemical and synthetic-rubber plants, and steel-plate mills. Lee College (1934) is located in the city. Pop. (1990) 63,850.

**Baza**, city, Granada province, in the autonomous community (region) of Andalusia, southern Spain, at the foot of the Sierra de Baza, northeast of Granada city. The city contains the ruins of a Moorish fort (*alcazaba*), and the Gothic collegiate church of Santa María is on the site of the old Gothic cathedral. Called Basti by the Romans and Baṣṭah by the Moors, the city was an episcopal see before the Moorish conquest and later became one of the chief cities of the kingdom of Granada. Its capture by the forces of the Catholic monarchs Ferdinand and Isabella, in 1489, was a famous episode in the history of the Reconquista (reconquest). French Marshal Nicolas-Jean de Dieu Soult won a victory over Spanish forces nearby during the Peninsular War (Aug. 10, 1810). Manufactured products include cement, pottery, and esparto fibre. There are mineral springs in the vicinity. Pop. (1981) 20,609.

**bazaar**, originally, a public market district of a Persian town. From Persia the term spread to Arabia (the Arabic word *sūq* is synony-

mous), Turkey, and North Africa. In India it came to be applied to a single shop; and in current English usage it is applied both to a single shop or concession selling miscellaneous articles and to a fair at which such miscellany is sold, often for charity.

The familiar bazaar of the ancient Islāmic nations is vividly described in the traditional folktales of *The Thousand and One Nights*. It is a distinct quarter of the town, access to which is forbidden after sundown, bustling and noisy by day, in contrast to the quiet residential quarters. Such a bazaar may be divided into districts, with all the purveyors of one type of merchandise grouped together. In smaller towns the bazaar consists of a single narrow street of stalls. In larger cities, such as Istanbul, it consists of many miles of such passageways. Some bazaars, such as those built at Kāshān and Isfahan (in Iran) in the 17th century, were designed with great architectural integrity. They were usually roofed for protection against the hot desert sun, either with a single roof, with individual vaulted cupolas or domes, or with awnings. Most ancient bazaars have gradually been modernized over the centuries.

**Bazaine, Achille (-François)** (b. Feb. 13, 1811, Versailles, Fr.—d. Sept. 28, 1888, Madrid), marshal of France who, after distinguished service during the Second Empire, was



Bazaine, detail from a lithograph by Jean-Baptiste-Adolphe Lafosse, 1869  
By courtesy of the Bibliothèque Nationale, Paris

sentenced to death for his surrender of Metz and 140,000 men to the Germans on Oct. 27, 1870, during the Franco-German War.

Bazaine was commissioned second lieutenant in 1833. As a colonel he led a brigade in the Crimean War and in 1855 was promoted to major general and appointed governor of Sevastopol. In the Franco-Sardinian war against Austria, he captured Solferino (June 24, 1859). Sent to Mexico in 1863, he conquered Puebla in May of that year, became commander of



Bazaar in Marrakech, Mor.  
Shostal Assoc.—EB Inc.



the French expeditionary force, and was promoted to marshal on Sept. 5, 1864.

On Aug. 10, 1870, just after the first major battle of the Franco-German War, Bazaine was appointed commander in chief. After a few indecisive engagements he withdrew into the entrenched camp at Metz. After the French defeat at Sedan (September 1), he negotiated with Otto von Bismarck, the Prussian chancellor, and on October 27 surrendered with his army of 140,000 men still intact.

For this action, Bazaine was sentenced, on Dec. 10, 1873, by a military court to degradation and death. Marshal Patrice de MacMahon, then president of the French Republic, commuted the sentence to 20 years' imprisonment. Bazaine escaped on Aug. 9, 1874, and died in exile and poverty.

Consult the INDEX first

**Bazalgette, Sir Joseph William** (b. March 28, 1819, Enfield, Middlesex, Eng.—d. March 15, 1891, London), civil engineer who designed the main drainage system for London.

After working on drainage and reclamation projects in Northern Ireland, Bazalgette became a consulting engineer at Westminster (1842). Seven years later he joined the London Metropolitan Commission of Sewers, becoming chief engineer in 1852. He was appointed chief engineer to the Metropolitan Board of Works in 1855.

Financial problems and conflicts among consultants held back work on the London drainage system until 1859. The system, containing 83 miles of intercepting sewers, was opened in 1865 and fully completed in 1875. Other works by Bazalgette included embankments—the Victoria, Albert (1860–70), and Chelsea (1871–74)—Northumberland Avenue (1876), new bridges at Putney and Battersea, and the Woolwich steam ferry. He was knighted in 1874 and served as president of the Institution of Civil Engineers (1883–84).

**Bazaruto Island**, Portuguese ILHA DO BAZARUTO, island, Mozambique, situated in the Mozambique Channel of the Indian Ocean, about 15 miles (24 km) offshore from the town of Inhassoro and 130 miles (209 km) southwest of Beira. Prior to independence (1975), Bazaruto Island was one of Africa's most important game-fishing centres. It lies in the coastal waters where a developing fishing industry now produces significant shrimp exports.

**Bazille, Jean-Frédéric** (b. Dec. 6, 1841, Montpellier, Fr.—d. Nov. 28, 1870, Beaune-la-Rolande), painter, who, as friend, benefactor, and colleague of the Impressionists, played an important role during the movement's formative years.



"Family Reunion," oil painting by Bazille, 1868; in the Louvre, Paris

Giraudon—Art Resource

Bazille was an unenthusiastic medical student before his wealthy parents permitted him to study painting. While a student in Paris, he met Monet and Renoir, with whom he worked, travelled, and shared his studio when they could not afford their own. He exhibited at the Salons of 1866 and 1868; in the latter, his "Family Reunion" (Louvre, Paris) had some success. As a painter he combined a certain naiveté with a delicate feeling for nature and an exquisite sense of colour. His landscape figures are strangely immobile and have a sculptural, hard-edge quality. Bazille, who seemed destined to occupy a prominent place among the Impressionists, was killed in the Franco-Prussian War.

**Bazin, Henri-Émile** (b. Jan. 10, 1829, Nancy, Fr.—d. Feb. 7, 1917, Dijon), engineer and member of the French Corps des Ponts et Chaussées (Corps of Bridges and Highways) whose contributions to hydraulics and fluid mechanics include the classic study of water flow in open channels.

He worked as an assistant to the noted hydraulic engineer H.-P.-G. Darcy (1803–58), after whose death Bazin finished his program of tests on resistance to water flow in channels, the results of which were published in 1865.

Bazin then carried his study over into the problem of wave propagation and the contraction of fluid flowing through an orifice. In 1854 he enlarged the Canal de Bourgogne and made it profitable for commercial navigation. In 1867 he suggested the use of pumps for dredging rivers, leading to the construction of the first suction dredgers.

Bazin became chief engineer of the Corps des Ponts et Chaussées in 1875 and was placed in charge of the Bourgogne canal system; he became inspector general in 1886. He retired in 1900 and was elected to the French Academy of Sciences in 1913.

**Bazin, Hervé**, pseudonym of JEAN-PIERRE-MARIE HERVÉ-BAZIN (b. April 17, 1911, Angers, Fr.), poet, novelist, short-story writer, and great-nephew of the Catholic traditionalist novelist René Bazin; he introduced vitality to the current of Naturalism in post-World War II French fiction.

After solid academic training, years of family conflict, and financial and professional failure, Bazin, a rebel and bohemian approaching middle age, finally achieved literary fame in 1948 with the autobiographical *Vipère au poing* (*Viper in the Fist*, 1951). His virulent, relentless attacks upon the institutions of family, church, and motherhood seemed to many Frenchmen to verge on blasphemy. The revolt continued in *La Tête contre les murs* (1949; *Head Against the Wall*, 1952), a novel about penal institutions and the judicial system that supports them, and in a second autobiograph-

ical novel, *La Mort du petit cheval* (1950; "The Death of a Small Horse"). Having exorcised the demons of his youth in his writings, Bazin underwent a spiritual metamorphosis,



Hervé Bazin, 1961

Lipnitchi—H. Roger-Viollet

from which he emerged a moralist. He discovered paternal love (*Au nom du fils*, 1960; *In the Name of the Son*, 1962), spiritual fortitude (*Lève-toi et marche*, 1952; *Constance*, 1955), and conjugal responsibility (*Le Matrimoine*, 1967). He departed from his mellow mood to exorcise a few remaining monsters in his world—a pyromaniac fireman in *L'Huile sur le feu* (1954) and a country Phaedra in *Qui j'ose aimer* (1956; *A Tribe of Women*, 1958). Later works include the novels *Madam Ex* (1975; "Madam X") and *Un Feu devore un autre feu* (1978; "A Fire Devours Another Fire") and the books of verse *Traits* (1976) and *Ce que je crois* (1977; "What I Believe"). He received the Grand Prix Littéraire de Monaco in 1957 for his literary work.

**Bazin, René (-François-Nicolas-Marie)** (b. Dec. 26, 1853, Angers, Fr.—d. July 20, 1932, Paris), influential French novelist of provincial life, strongly traditionalist in outlook; his works express in simple but elegant style his love of nature, of simple virtues, and of work, especially on the land.

Educated in Paris and Angers, Bazin became a professor of law at the Catholic University at Angers, remaining close throughout his life to the people and scenes of his native countryside. His early works presented an extremely idealistic view of peasant life, but after travels in Spain and Italy, begun in 1893, he acquired an insight into the universality of peasant themes that is reflected in his later, more forceful novels. *La Terre qui meurt* (1899) deals poignantly with the theme of emigration, as one by one the younger generation of a Vendée family leave their impoverished family farm to seek their fortunes in the city or in America. *Les Oberlé* (1901) concerns the Germanization of Alsace-Lorraine, in depicting the conflicts of divided loyalty within the Oberlé family. *Donatienne* (1903) is an account of the fortunes of a young Breton couple. Forced by poverty, the young mother, Donatienne, goes into service in the city, where she succumbs to the corruption of city life. The young husband, after losing his farm, leads the wretched life of a migrant worker, travelling from place to place with the children. Years after, spoiled Donatienne is reunited with her family and matter-of-factly takes up her duties as a peasant wife. *Le Blé qui lève* (1907) portrays the corrupting influence of trade unionism on woodcutters.

Though Bazin's works are now considered obsolete, he was an influential traditionalist in his day and a respected member of the spiritual family of French Catholic writers that includes, among others, Maurice Barrès, Georges Bernanos, and François Mauriac.

**Baziotes, William** (b. June 11, 1912, Pittsburgh, Pa., U.S.—d. June 4, 1963, New York, N.Y.), American painter who was one of the leading members of the New York Abstract



Baziotes, 1959

© Arnold Newman

Expressionist group from the late 1940s, when it became the most influential movement in international art.

Baziotes studied with Leon Kroll at the National Academy of Design in New York City (1933–36) and worked as a teacher (1936–41) with the WPA Federal Art Project. In the late 1940s he founded the school “Subject of the Artist” with fellow painters Robert Motherwell, Barnett Newman, and Mark Rothko in New York City, where open discussion sessions and lectures were well attended.

Influenced by Cubism in its emphasis on structure and by Surrealism in its emphasis on automatism and the unconscious, Baziotes’ works often develop around biomorphic shapes reminiscent of marine-life forms.

**Bazna, Elyesa:** see Cicero.

**bazooka**, shoulder-type rocket launcher adopted by the U.S. Army in World War II. The weapon consisted of a smooth-bore steel tube, originally about 5 feet (1.5 m) long, open at both ends and equipped with hand grip, shoulder rest, trigger mechanism, and sights. Officially titled the M9A1 Rocket Launcher, it was called bazooka after a crude horn of that name used by radio comedian Bob Burns.

The bazooka was developed chiefly for attacking tanks and fortified positions at short range. It launched a 3.5-pound (1.6-kilogram) rocket with a diameter of 2.36 inches (60 mm) and a length of 19 inches (483 mm). The rocket carried 8 ounces (225 g) of pentolite, a powerful explosive that could penetrate as much as 5 inches (127 mm) of armour plate. To escape backblast, the operator held the bazooka on his shoulder with about half the tube protruding behind him. During the Korean War the M20 “Super Bazooka” was used. This was an aluminum tube that launched a 3.5-inch (89-millimetre), nine-pound (four-kilogram) rocket carrying 2 pounds (0.9 kg) of combined RDX/TNT explosive. The chief defects of both bazookas were their cumbersome weight and length and their short effective range (about 120 yards [110 m]). For this reason, beginning in the Vietnam War the U.S. Army abandoned bazookas in favour of light antitank weapons, or LAWs, such as the M72, a one-shot, disposable weapon that weighed 5 pounds (2.3 kg) fully loaded yet could launch its rocket with reasonable accuracy out to 350 yards (320 m).

**Bazzi, Giovanni Antonio:** see Sodoma, II.

**BBC:** see British Broadcasting Corporation.

**BCG vaccine**, vaccine against tuberculosis, prepared from a weakened strain of tuberculosis bacteria named BCG—*bacille Calmette-Guérin*, for the French scientists who developed the product. The vaccine is of particular importance for those whose occupations carry

a high risk of infection by tuberculosis, such as nurses and physicians, and for persons in countries with high rates of tuberculosis.

**BCS theory**, in physics, a comprehensive theory developed in 1957 by the American physicists John Bardeen, Leon N. Cooper, and John R. Schrieffer (their surname initials providing the designation BCS) to explain the behaviour of superconducting materials. Superconductors abruptly lose all resistance to the flow of an electric current when they are cooled to temperatures near absolute zero.

Cooper had discovered that electrons in a superconductor are grouped in pairs, now called Cooper pairs, and that the motions of all of the Cooper pairs within a single superconductor are correlated; they constitute a system that functions as a single entity. Application of an electrical voltage to the superconductor causes all Cooper pairs to move, constituting a current. When the voltage is removed, current continues to flow indefinitely because the pairs encounter no opposition. For the current to stop, all of the Cooper pairs would have to be halted at the same time, a very unlikely occurrence. As a superconductor is warmed, its Cooper pairs separate into individual electrons, and the material becomes normal, or nonsuperconducting.

Many other aspects of the behaviour of superconductors are explained by the BCS theory. The theory supplies a means by which the energy required to separate the Cooper pairs into their individual electrons can be measured experimentally. The BCS theory also explains the isotope effect, in which the temperature at which superconductivity appears is reduced if heavier atoms of the elements making up the material are introduced.

**BD**, abbreviation of *Bonner Durchmusterung* (q.v.), an astronomical catalog.

**be**, any of the hereditary occupational groups in early Japan (c. 5th–mid-7th century), established to provide specific economic services and a continuous inflow of revenue for the *uji*, or lineage groups. Each *be* was thus subsidiary to one of the *uji* into which all of Japanese society was then divided, and each *kakibe*, or worker, was effectively owned by the chief of his *uji*. Most *be* were agricultural units, producing rice for themselves and their superiors, but some engaged in crafts, fishing, or specific court functions. Those that acted as scribes, interpreters, diviners, or reciters for the court were national organizations; most other types of *be* were local.

After the Taika-era reforms (AD 645) asserted imperial rule over the various *uji*, all *be* were abolished with the exception of those for specially skilled workers such as musicians and craftsmen, whose services were transferred from the imperial family to individual governmental departments.

**beach**, sediments that accumulate along the sea or lake shores, the configuration and contours of which depend on the action of coastal processes, the kinds of sediment involved, and the rate of delivery of this sediment. There are three different kinds of beaches. The first occurs as a sediment strip bordering a rocky or cliffy coast; the second is the outer margin of a plain of marine or fluvial accumulation (free beaches); and the third, of fairly peculiar character, consists of the narrow sediment barriers stretching for dozens or even hundreds of kilometres parallel to the general direction of the coast. These barriers separate lagoons from the open sea and generally are dissected by some tidal inlets. Certain sediment forelands, such as spits, points, and tombolos (which connect an island with a mainland), also occasionally are called beaches.

The upper limit of the active beach is the swash line reached by highest sea level during big storms. The lower beach margin is beneath the water surface and can be determined only

if there is a definite border present between the sediment layer and the naked surface of the rocky bench. If the sediment cover extends into deep water, the lowest beach margin may be defined as the line where the strongest waves no longer sort and move the sand. It occurs approximately at a depth equal to one-third the wavelength or 10 times the wave height.

The profile of an active beach varies greatly. Its form and dimensions depend on a number of factors, such as wave parameters, tide height, and sediment composition and distribution. The following, however, constitute some of the profile elements that commonly occur. At the upper part, above high sea level, a beach terrace is located, and there may be a series of beach ridges or berms created by the waves of a previous major storm. This terrace surface is inclined seaward. The next element is a steeper, frontal beach slope or face, and beneath it a low-tide terrace may be developed. If the tides are high enough (more than 2 m [6.6 feet]), the frontal slope may be more than 1 km (0.6 mile) in width in regions with abundant sand and a shallow bottom. In some areas the low-tide terrace terminates with another inclined shoreface, if the nearshore sea zone is rather deep. Finally, one or several parallel, submarine, long-shore bars with intervening troughs may exist along sandy shores; if present, these bars constitute the last profile element.

Some minor relief forms are usually present on the surface of sand beaches. These include oscillation ripples, swash or rill furrows, and the well-known beach cusps (concave seaward) at the beach margin.

Given the established system of strong waves normal to the shoreline, submarine bars are sometimes dismembered and are converted into large crescent elements convex seaward. These relief forms reflect the existence of large water eddies with vertical axes, which form as a result of the ebb and flow of the water. Often the water outflow proceeds in the form of linear rip currents. These may be so strong that they cause erosion of deep channels in the submarine slopes.

In many countries the wind strongly affects the dynamics of the beach. The beach is exposed to the sea wind, and sand is usually blown off to the rear parts of the beach, where it forms small hummocks. As these join together, foredunes are being built, and, if the beach is well-supplied with sand in the right area, several rows of dunes will be formed. When the sand is abundant, dunes will shift to adjacent low-lying plains and may bury fertile soils, woods, and buildings (see Figure).

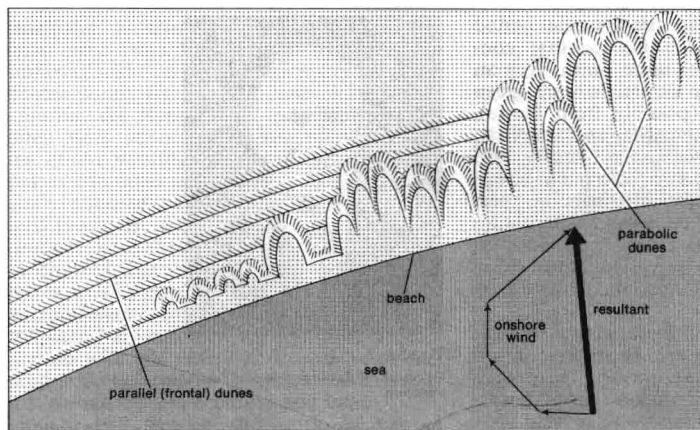
If sand is no longer delivered to the region of developed dunes, gaps will form in the ridges parallel to the shore. In such zones, parabolic dunes with their summits coastward are created. After long stabilization, the summits of the parabolas may be broken through by the wind, thus gradually forming a series of ridges parallel to the prevailing winds.

Beach sands in temperate latitudes consist mainly of quartz, some feldspars, and a small percentage of heavy minerals. In the tropics, however, calcareous beaches composed of skeletal remnants of marine organisms and precipitated particles, such as oolites, are widespread.

Sometimes the basement layers of the beach are cemented by calcium carbonate, precipitated from the groundwater. This will commonly result if fresh water penetrates a beach from swamps behind it. If the beach undergoes erosion and thus retreats, the cemented strata become exposed; termed beach rock, they are widespread in the tropics and along the shores of the Mediterranean, Black, and Caspian seas.

The practical significance of beaches is not limited to their function as protectors of the coast or as recreation sites. The sorting mech-





Scheme of frontal and parabolic shore dunes behind the beach and the onshore wind resultant

From E.C.F. Bird, *Coasts* (1968), p. 139; The Australian National University Press

anism of the offshore waves and currents determines the accumulation of heavy-mineral (specific weight more than 2.7) concentrates. On any sand beach there are thin layers of dark sand that can be seen. Some heavy minerals contain valuable metals, such as titanium, zirconium, germanium, tin, uranium, and gold. In many places the concentrations are so great that they are of industrial significance; placer deposits are worked in India, Brazil, Japan, Australia, Russia, and Alaska. Heavy-mineral concentrates also are extracted from the submarine slopes by means of dredging ships.

**Beach, Alfred Ely** (b. Sept. 1, 1826, Springfield, Mass., U.S.—d. Jan. 1, 1896, New York City), U.S. publisher and inventor; his *Scientific American* performed signal service in stimulating 19th-century technological innovations, and Beach himself invented a tunnelling shield and the pneumatic tube, among other devices.

While Beach was attending Monson Academy in Massachusetts, his father bought the New York *Sun*, and at 22 Beach became co-publisher with his brother Moses Beach. The new magazine *Scientific American* interested him more, however, and he purchased it, announcing in his first issue that it would secure patents for U.S. inventors. For the next several decades Beach made biweekly trips to Washington, D.C., to carry out this pledge. In 1847 he applied for his own first patent, on a typewriter, and a few years later, at the Crystal Palace Exhibition of 1853, New York City, he displayed a version of his machine that produced embossed letters for the blind.

Beach originally envisioned the pneumatic tube as a means of delivering mail in downtown areas of cities, a use to which it was widely put, but in the 1860s, after experimenting with a cable railway, he conceived the idea of a pneumatic subway. At the Fair of the American Institute in New York City in 1867, he exhibited a tube in which a 10-passenger car was driven back and forth by a powerful fan. Because of the opposition of Boss Tweed, the political ruler of New York City, Beach found it necessary to construct an experimental subway in secret. Obtaining a charter in 1868 for a 4-foot pneumatic tube to demonstrate mail delivery, he actually dug an 8-foot bore tunnel 300 feet (100 metres) under Broadway, between Warren and Murray streets. Because he could not disturb street traffic with a trench, he was forced to drive the tunnel by underground methods and invented a cylindrical tunnelling shield, powered by hydraulic rams; this shield actually antedated that built by James Henry Greathead for the Tower Subway in London. A 100-horsepower blower, operating alternately as an exhaustor, pushed and pulled the single car back and forth in the tunnel. The demonstration was

a success, but adoption was blocked partly by Tweed's opposition, partly by the financial panic of 1873, and finally by the arrival of electric traction. In the 1960s the idea was revived in the form of a proposed gravity-vacuum train for long-distance high-speed transportation.

**Beach, Amy Marcy**, née CHENEY, married name MRS. H.H.A. BEACH (b. Sept. 5, 1867, Henniker, N.H., U.S.—d. Dec. 27, 1944, New York City), U.S. pianist and composer known for her *Piano Concerto* (1900) and her *Gaelic Symphony*, the first symphony by an American woman composer.

At 16 she became a professional pianist. Largely self-taught as a composer, she was the only woman member of the Boston school of U.S. composers, who were heavily influenced by the German Romantic style. She was a prolific composer of choral works, piano pieces, and songs, of which "Ah, Love, but a Day" and "The Year's at the Spring" became particularly popular.

**Beach, Sir Michael Edward Hicks:** see Hicks Beach, Sir Michael Edward.

**Beach, Sylvia** (b. March 14, 1887, Baltimore—d. Oct. 5, 1962, Paris), bookshop operator who became important in the literary life of Paris, particularly in the 1920s, when her shop was a gathering place for expatriate writers and a centre where French authors could pursue their newfound interest in U.S. literature.

The daughter of a Presbyterian minister, Beach developed at 14 a lifelong love of France when her father held a pastorate in Paris among American students. In 1919 she opened her shop, Shakespeare and Company, which included a lending library, on the Left Bank in Paris. Perhaps her most heroic service to literature was her publication in 1922 of James Joyce's *Ulysses* after it had been turned down by several other publishers because of its explicit sexual content. She allowed Joyce the unlimited right to correct the proofs of his complex work, a lengthy process that she guided through typesetters unfamiliar with English. Her shop was closed in 1941, not to reopen, and she was interned for seven months by the occupying Germans. She wrote about her shop and its literary life in *Shakespeare and Company* (1959).

**beach flea:** see sand flea.

**beach grass**, also called MARRAM GRASS, PSAMMA, or SAND REED, any of the sand-binding plants in the genus *Ammophila* (family Poaceae). These coarse, perennial grasses are about one metre (about three feet) tall and grow on sandy coasts of temperate Europe, North America, and northern Africa.

American beach grass (*A. breviligulata*) grows along the Atlantic coast and in the Great

Lakes region. European beach grass (*A. arenaria*) has been introduced on the northern Pacific coast of the United States as a dune stabilizer. Both species grow in tufts and have rolled, spikelike leaves. The flower clusters are long, dense, and cylindrical. The tough, scaly underground stems may spread 10 to 13



American beach grass (*Ammophila breviligulata*)

Karlene Schwartz

metres (33 to 43 feet) away from the plant, sending up new shoots throughout the dune. In some areas, beach grass is protected by law.

**beach hopper:** see sand flea.

**Beach-la-Mar** (language): see Melanesian Pidgin.

**beach pea** (*Lathyrus maritimus*, sometimes *L. japonicus*), sprawling perennial plant in the pea family (Fabaceae). It occurs on gravelly and sandy coastal areas throughout the North Temperate Zone. The stem is 30–60 centime-



Beach pea (*Lathyrus maritimus*)

Thomas W. Martin—Rapho/Photo Researchers

tres (1–2 feet) long. The alternate leaves are divided into 6 to 12 leaflets arranged along the leafstalk. The purplish-blue flowers, which appear throughout the summer, are followed by a hairy pod about 3 cm long.

**Beachy Head**, prominent headland on the English Channel coast in the county of East Sussex, England, in the borough of Eastbourne. Its chalk cliffs, more than 500 ft (150 m) high, represent the seaward extension of the South Downs. The cliffs face southward and are therefore subjected to severe gales from the southwest. Erosion is concentrated along joint planes and tends to produce isolated stacks. There were once seven of these, the Seven Charleses; the last fell in 1875.

**Beacon**, city, Dutchess County, southeastern New York, U.S., at the foot of Mt. Beacon, on the east bank of the Hudson River, there bridged to Newburgh, 58 mi (93 km) above New York City. It became a city when the 17th-century villages of Matteawan and Fishkill Landing were united in 1913. The name was inspired by the fires that blazed atop Mt. Beacon to warn George Washington of British troop movements; the mountain is now a resort, and the Mt. Beacon Incline Railway (1901) ascends its west spur (1,540 ft [469 m]

above the river). Industrialization began after the War of 1812 when John Jacob Astor and others built a cotton mill and foundry. Manufactures now include clothing, aluminum and rubber fabricated products, and fans. Madam Brett Homestead (1709) in Beacon and Van Wyck Homestead (1732; site of Revolutionary War courts-martial) in Fishkill are preserved as museums. Pop. (1990) 13,243.

**Beaconsfield**, town in northern Tasmania, Australia. It lies on the west bank of the Tamar River, 29 miles (46 km) northwest of Launceston. The site of the present town, originally known as Cabbage Tree Hill, was renamed Brandy Creek when gold was found nearby in 1870. In 1879 F.A. Weld, governor of Tasmania, gave the town its present name in honour of Benjamin Disraeli, the 1st Earl of Beaconsfield. Between 1877 and 1919 Beaconsfield's Tasmania Mine was the largest single source of gold in the state, reaching its peak in gold production in 1899. Today gold is mined together with copper, lead, and zinc. Beaconsfield is also an agricultural centre producing apples, dairy products, and oysters. Inc. town, 1908. Pop. (1986 prelim.) 226.

**Beaconsfield**, town, in South Bucks (formerly Beaconsfield) district, county of Buckinghamshire, England, in the Chiltern Hills.

The wide main street of the old town of Beaconsfield, bordered by 18th-century houses, contrasts with the modern town, in which commuters to London—28 miles (39 km) to the southeast—reside. Beaconsfield was adopted by Benjamin Disraeli, the 19th-century British prime minister, for his earl's title and was also the home of Edmund Burke, the 18th-century statesman, who is buried in the parish church. Pop. (1981) 11,028.

**Beaconsfield, Benjamin Disraeli, Earl of:** see Disraeli, Benjamin.

**bead**, small, usually round object made of glass, wood, metal, nut, shell, bone, seed, or the like, pierced for stringing. Among primitive peoples, beads were worn as much for magical as for decorative purposes; hence, little variation was allowed in their shapes and materials. In Arab countries in the 20th century, single blue talismanic beads are attached to domestic animals, children, brides, and even automobiles to avert bad luck. Because of the value attached to them as light articles of trade and as substitutes for coinage, beads yield valuable information about ancient trade and cultural patterns.

In prehistoric times, beads were worn not only around the neck but around the hips, over the ears, threaded through the nose, and even attached to the eyelashes. In the Stone Age, the earliest beads probably were plant seeds; but, by Acheulian times, collars of seashells and small fossils were bored for stringing, and, from the Aurignacian and Magdalenian periods, whole necklaces of pierced shells have survived, some of them carried long distances from the sea. Collars made of the pierced canine teeth of Arctic foxes and of chamois and human teeth pierced for stringing also have been found. A type of bilobed bead carved out of mammoth ivory was often worn in Siberian Paleolithic settlements. It was perhaps ancestral to a bone or stone bead of double-ax shape that was popular in the Neolithic period, especially in northern Europe, Britain, and southern France. Beads of stone, bone, and amber, pierced through their narrower ends, became common in the Late Neolithic Period in Scandinavia and are found in Megalithic graves of western Europe.

The earliest Egyptian beads, dating from about 4000 bc, are generally made of stone, usually steatite (soapstone), covered with a near-glass glaze; glass itself is not found un-

til much later. In the pre-dynastic period appeared beads of blue faience that continued essentially the same until Roman times. Other favourite materials were green feldspar, lapis lazuli (possibly from Persia), carnelian, turquoise, hematite, and amethyst. Usually these materials were made into spherical, barrel-shaped, or discoidal beads; but locust, falcon, crouching-baboon, hippopotamus-head, and conus-shell shapes are well represented. Phoenician workshops at Carthage and in the Egyptian delta made fancy beads in the form of comic human faces and animal heads.

In the Sumerian and Indus valley civilizations, variously shaped gold beads were in use by the early 3rd millennium bc. There were tubular, spherical, and melon-shaped beads, but most distinctive was a tubular bead with two semicircular wings attached to each side, as though in imitation of a plant seed. By 2000 bc a spherical bead resembling a nasturtium seed, with light flutings along the line of the piercing, was in use; it remained popular with the Babylonians and lasted into Assyrian times. Meanwhile, the Minoan and Mycenaean peoples of Crete and the Aegean developed gold beads of great originality and beauty in the shapes of polyps, lilies, and lotuses; there are also a number of spherical Mycenaean gold beads decorated with granulated patterns. Beads of opaque glass with impressed circlets of glass of a different colour came to Britain and western Europe in the Late Bronze Age. Their precise origin is unknown, but they probably were manufactured in the Mediterranean.

Among the Indians of North and South America, a great quantity of stone and shell beads commonly was worn, the latter being either complete shells or shaped out of shell. On the whole, except in the classical Inca civilizations of Peru, beads of fine stone were rare. Some, of a curious shape that suggests a double ax, are Peruvian, but there are elaborate Aztec and Inca beads of jadeite and other coloured stones in shapes such as frogs and human skulls. A number of sites in Peru, Guiana, and Honduras have yielded elaborate tubular gold-filigree beads.

Since the European Middle Ages, beads have been used extensively for trade and barter. Explorers have found them invaluable as gifts for primitive peoples, and, during the 17th and 18th centuries, this trade in beads was enormous. Their importance was well known to the Spanish conquistadores, whose gifts of Renaissance glass beads manufactured in Venice are said to have been worn until recent times by primitive peoples of Brazil. The use of beads as personal decoration has continued on and off throughout history, the richness of ornamentation varying with fashions.

**bead lightning**, also called CHAIN LIGHTNING, form of lightning of long duration that appears as a string of luminous segments instead of a continuous channel. It occurs infrequently but has been observed many times. Its causes are unknown, but among the theories proposed are the following: portions of the lightning channel are slanted toward or away from the observer and thus seem brighter; parts of the channel are obscured by rain or clouds; and sections of the channel with large radii cool more slowly than do those with small radii.

**Beadle, George Wells** (b. Oct. 22, 1903, Wahoo, Neb., U.S.—d. June 9, 1989, Pomona, Calif.), American geneticist, Nobel laureate, and president of the University of Chicago (1960–68), who helped found biochemical genetics when he showed that genes affect heredity by determining enzyme structure.

After earning his Ph.D. in genetics from Cornell University (1931), Beadle went to the laboratory of Thomas Hunt Morgan at the California Institute of Technology, where



Beadle

By courtesy of California Institute of Technology, Pasadena

he did work on the fruit fly, *Drosophila melanogaster*. Beadle soon realized that genes must influence heredity chemically. In 1935, with Boris Ephrussi at the Institut de Biologie Physico-Chimique in Paris, he designed a complex technique to determine the nature of these chemical effects in *Drosophila*. Their results indicated that something as apparently simple as eye colour is the product of a long series of chemical reactions and that genes somehow affect these reactions.

After a year at Harvard, Beadle pursued gene action in detail at Stanford University in 1937. Working there with Edward Tatum, he found that the total environment of a red bread mold, *Neurospora*, could be varied in such a way that the researchers could locate and identify genetic changes, or mutants, with comparative ease. They exposed the mold to X rays and studied the altered nutritional requirements of the mutants thus produced. These experiments enabled them to conclude that each gene determined the structure of a specific enzyme that, in turn, allowed a single chemical reaction to proceed. This "one gene—one enzyme" concept won Beadle and Tatum (with Joshua Lederberg) the 1958 Nobel Prize for Physiology or Medicine. Further, the use of genetics to study the biochemistry of microorganisms, outlined in the landmark paper "Genetic Control of Biochemical Reactions in *Neurospora*" (1941), by Beadle and Tatum, opened up a new field of research with far-reaching implications. Their methods immediately revolutionized the manufacture of penicillin and provided insights into many biochemical processes.

In 1946 Beadle became professor and chairman of the biology division at the California Institute of Technology and served there until 1960, when he was invited to succeed R. Wendell Harrison as chancellor of the University of Chicago; the title of president was reassigned to the position a year later. He retired from the university to direct (1968–70) the American Medical Association's Institute for Biomedical Research. His major works include *An Introduction to Genetics* (1939; with A.H. Sturtevant), *Genetics and Modern Biology* (1963), and *The Language of Life* (1966; with Muriel M. Beadle).

**beadwork**, use of beads in fabric decoration; beads may be individually stitched, applied in threaded lengths, or actually woven into the material, the weft threaded with beads before being woven in. Glass beads were used decoratively in ancient Egypt, Greece, and Rome and by the druids in religious rites.

During the Middle Ages, when embroidery was an important art form, beads sometimes were used in the finest embroidery work. The magnificent Butler-Bowden cope, a long ecclesiastical vestment (English, c. 1330; Victoria and Albert Museum, London), was elaborately embellished with seed pearls and green beads. Examples of beadwork of a purely pictorial, rather than decorative, nature also survive from this period. A series of small portraits of apostles executed entirely with coloured beads



stitched to a vellum backing are believed to have come from the Halberstadt (Germany) cathedral and may have been inspired by small contemporary Byzantine mosaics.

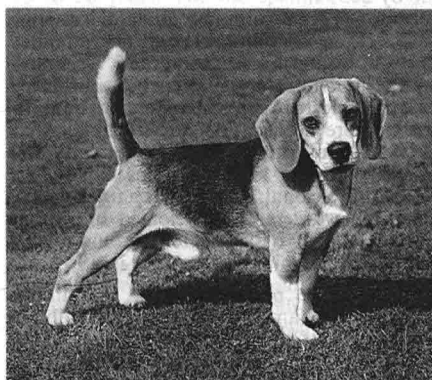
During the Renaissance, pearls and beads often were sewn in patterns on the clothing of the wealthy. In Elizabethan England, purses and other small objects often were liberally adorned with gilt thread, beads, and seed pearls. By the third quarter of the 17th century, beadwork had become so popular in England that many articles—chiefly fancy boxes, small pictures, and a particular form of basket—were decorated all over with beads. In southern Italy and Sicily, a bold form of decoration with gilt thread and coral beads was produced, apparently in considerable quantity, during the 17th century and later.

In the 18th century beadwork fell out of favour in Europe, but it became popular again during the 19th century. Purses knitted with bead-threaded cotton were particularly popular shortly after 1800, and throughout the 19th century such small articles as gloves, mittens, belts, garters, stockings, and parasol covers frequently were decorated with beads. A great many women's dresses were richly ornamented with beads of all kinds. Beadwork as dress decoration recurred periodically in the 20th century.

The simplest and earliest American Indian beadwork may have been a string made from bone, shell, or seeds. The introduction of glass trade beads by Europeans between the 15th and 19th centuries stimulated more complex designs. Among the Plains Indians, beadwork designs originally were geometrical, similar to the old porcupine-quill or moose-hair embroidery, and were placed on skin clothing, bags, and other articles. In the 19th century, floral designs became popular. The Eskimos of Greenland and North America use beadwork to ornament thigh boots, capes, and tunics.

Throughout Africa beadwork is used to ornament ceremonial headdresses, tunics, masks, baskets and other vessels, dolls, and a variety of other objects. Motifs and palettes vary

solidly built dog, heavy for its height. It generally excels as a rabbit hunter and is typically an alert, affectionate dog. There are two sizes recognized in the breed: beagles standing less



Beagle  
Sally Anne Thompson—EB Inc.

than 13 inches (33 centimetres) and weighing about 18 pounds (8 kilograms) and those standing about 15 inches (38 centimetres) and weighing about 30 pounds (13.5 kilograms).

**Beagle**, British naval vessel aboard which Charles Darwin served as naturalist on a surveying expedition (1831–36) in the Pacific and elsewhere. On that sailing, the *Beagle*, a brig displacing about 240 tons, was commanded by Robert Fitzroy (q.v.). Darwin sailed from Devonport, Eng., in the *Beagle* on Dec. 27, 1831. After circumnavigating the globe, the *Beagle* arrived back at Falmouth, Eng., on Oct. 2, 1836. The voyage provided Darwin with the observations that led him toward the theory of evolution.

**Beagle Channel**, strait in the Tierra del Fuego archipelago at the southern tip of South America. The channel, trending east–west, is about 150 mi (240 km) long and 3 to 8 mi wide; it separates the archipelago's main island to the north from Navarino, Hoste, and other smaller islands to the south. At its western end the channel splits into two branches that encircle Isla Gordon. The eastern portion forms part of the Chile–Argentina border, while the western portion lies entirely within Chile. The three islands at the channel's eastern end, Picton, Nueva, and Lennox islands, were the subject of a territorial dispute between Chile and Argentina that began in the 1840s and which almost led to war between the two nations in 1978. The dispute officially ended on May 2, 1985, when a treaty awarding the three islands to Chile went into effect between the two countries. The *Beagle Channel* was named for the British ship *Beagle*, in which Charles Darwin explored the area (1833–34).

**beak**, also called **BILL**, stiff, projecting oral structure of certain animals. Beaks are present in a few invertebrates (e.g., cephalopods and some insects), some fishes and mammals, and all birds and turtles. Many dinosaurs were beaked. The term bill is preferred for the beak of a bird, platypus, or dinosaur. Many beaked animals, including all birds and turtles, lack teeth.

A bird's bill is composed of the upper and lower jaws covered by a horny sheath of skin. The nostrils are found dorsally, usually at the base of the bill. Bills take many shapes and sizes, adapted for food-getting, preening, nest-building, and other functions. Feeding modifications alone include the pouched fish-netting bill of pelicans; the serrated grazing bill of geese; the long, slim nectar-sipping bill of hummingbirds; and the sturdy, curved nut-cracking bill of parrots.

**beak style**, distinctive use of birdlike forms in human figures carved in wood in the lower Sepik and Ramu regions of Papua New

Guinea. The head of the figure is generally placed on a short neck that connects it to a thick body, over which a long, beaklike nose often projects. Facial features have a thin, linear quality that emphasizes the downward thrust of the nose and contrasts with the robust heaviness of the limbs of the full-length figures.

Examples of the beak style are seen in masks, statues, and utilitarian objects such as headrests, which are frequently painted and decorated with shells, tufts of hair, feathers, and bits of fibre and cloth. A sculptural form similar to the beak style is known in Vanuatu



Painted wooden neckrest in the beak style with cowrie-shell decoration, c. 1870, from the Sepik River district, Papua New Guinea; in the Rautenstrauch-Joest-Museum, Cologne  
By courtesy of the Rautenstrauch-Joest-Museum, Cologne

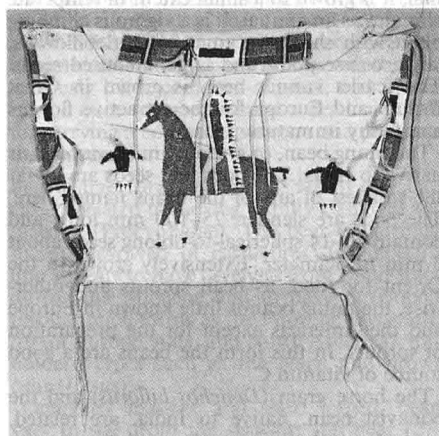
(formerly the New Hebrides) and New Caledonia.

**beaked nightshade** (plant): see buffalo bur.

**beaked whale**, any of a family (Ziphiidae, or, in some classifications, Hyperoodontidae) of medium-sized toothed whales (suborder Odontoceti), encompassing 6 genera and about 18 species, including the bottlenose whales. Members of the family are characterized by an extended beaklike snout, small rounded flippers, a dorsal fin set toward the rear, two throat grooves that meet under the chin, and the lack of a central notch in the wide flukes. The stomach is compartmented, containing up to 14 sections. In almost all beaked whale species, functional teeth are limited to one or two pairs, present only in the lower jaw and usually erupting through the gums only in the male whale. In the remarkable strap-toothed whale (*Mesoplodon layardii*), these teeth curve up and out, around the upper jaw, holding it partially shut. Shepherd's beaked whale (*Tasmacetus*) is also unusual, as it has numerous small functional teeth.

Beaked whales are distributed throughout the world, although certain species are limited to one ocean. Ranging in size from 3.5 metres (12 feet) for Hector's beaked whale, *M. hectori*, to 12.8 m for the giant bottlenose whale, *Berardius bairdii*, these whales weigh between 1,000 and 11,000 kilograms (1.1 and 12 tons). Colour is variable but is usually some combination of gray or black with white. Their bodies are often covered with long scars from fighting with each other. Beaked whales are the least known of the large mammals, and the mystery continues as the bodies of undescribed species occasionally drift ashore.

Rapid swimmers and deep divers, beaked whales are teuthophagous (squid-eating), although most also eat fish and bottom-dwelling



Arapaho beaded storage bag c. 1890; in the Denver Art Museum, Colorado

By courtesy of the Denver Art Museum, Colorado

among the peoples, with a vivid and sophisticated geometry predominating. Beadwork in Africa has also been used to convey information (e.g., Zulu love messages).

Beads are used over most of Southeast Asia, mainly as dress and weapon ornaments. Borneo beadwork, exceptionally, uses curvilinear zoomorphic ornament, mostly in black, yellow, and red. Oceanic beadwork is simpler and, except in Melanesia, tends to rely on natural materials such as wood and shell.

**beagle**, small hound-dog breed popular as both a pet and a hunter. It looks like a small foxhound and has large brown eyes, hanging ears, and a short coat, usually a combination of black, tan, and white. The beagle is a

invertebrates. Some are solitary or travel in small groups, while others may appear in pods of 30 or more. Groups often surface and dive in unison. *See also* bottlenose whale.

**Beaker folk**, Late Neolithic–Early Bronze Age people living about 6,000 years ago in the temperate zones of Europe; they received their name from their distinctive bell-shaped beakers, decorated in horizontal zones by finely toothed stamps. (Their culture is often called the Bell-Beaker culture.) The graves of the Beaker folk were usually modest single units, though in much of western Europe they



Beaker found at Denton, Lincolnshire, Eng.  
By courtesy of the trustees of the British Museum

often took the form of megalithic tombs. A warlike stock, they were primarily bowmen but were also armed with a flat, tanged dagger or spearhead of copper, and a curved, rectangular wrist guard. Their extensive search for copper (and gold), in fact, greatly accelerated the spread of bronze metallurgy in Europe. Probably originally from Spain, the Beaker folk soon spread into central and western Europe in their search for metals. In central Europe they came into contact with the Battle-Ax (or Single-Grave) culture, which was also characterized by beaker-shaped pottery (though different in detail) and by the use of horses and a shaft-hole battle-ax. The two cultures gradually intermixed and later spread from central Europe to eastern England.

**beam**, in engineering, originally a solid piece of timber, as a beam of a house, a plow, a loom, or a balance. In building construction, a beam is a horizontal member spanning an opening and carrying a load that may be a brick or stone wall above the opening, in which case the beam is often called a lintel (*see* post-and-lintel system). The load may be a floor or roof in a building, in which case the beam is called a floor joist or a roof joist. In a bridge deck the lightly loaded longitudinal beams are the stringers; the heavier, transverse members are called floor beams.

Large beams carrying the ends of other beams perpendicular to them are usually called girders. Metal girders may be single rolled pieces or, to permit greater stiffness and longer spans, may be built up in the form of an I by rivetting or welding plates and angles. Concrete girders are also widely used.

Beams may be of wood, steel or other metals, reinforced or prestressed concrete, plastics, and even brickwork with steel rods in the bond between bricks. For weight reduction, beams of metal are formed as an I or other shape having a thin vertical web and thicker horizontal flanges where most of the strain appears. *See also* cantilever.

**Beamon, Bob** (b. Aug. 29, 1946, Bronx, New York City), U.S. long jumper who set a world

record of 29 ft 2½ in. (8.90 m) at the 1968 Olympic Games at Mexico City. He was then a student at the University of Texas at El Paso. The new record surpassed the preceding one by 21½ in.

Beamon began jumping at Jamaica High School (Long Island, N.Y.) and first attended North Carolina Agricultural and Technical College (Greensboro). Later he transferred from El Paso to Adelphi University (Long Island), where he also played basketball. After his 1968 record, he competed irregularly and retired before the 1972 Olympics. In 1973 he turned professional; later he was a track coach, did youth work, and participated in various sports-related activities, including fund raising for the U.S. Olympic Committee in 1984.

**bean**, seed or pod of certain leguminous plants of the family Fabaceae, originally of *Vicia faba*, an Old World species called Windsor bean, broad bean, and horsebean. The mature seeds of the principal beans used for food, except soybeans (*q.v.*), are rather similar in composition, although they differ widely in eating quality. Rich in protein and providing moderate amounts of iron and vitamins B<sub>1</sub> and B<sub>2</sub>, beans are used worldwide for cooking in either fresh or dried form.

Most varieties of the common bean grow either as an erect bush 30–75 centimetres (12–30 inches) tall or as a climbing plant 1.2–2.1 metres (50–80 inches) long, but a few important kinds are of intermediate form. Dwarf and semiclimbers are grown extensively. When the climbing type is grown for its immature pods, artificial supports are necessary to facilitate harvesting. Varieties differ greatly in size, shape, colour, and fibrousness or tenderness of the immature pods. In general, varieties grown



Bean (*Phaseolus vulgaris*)  
Walter Chandoha

for dry mature seeds produce pods that are too fibrous to be eaten at any state of development. Most edible-podded beans produce relatively low yields of mature seeds, or seeds that are of low eating quality. Seed colours range from white through green, yellow, tan, pink, red, brown, and purple to black in solid colours and countless contrasting patterns. Seed shapes range from nearly spherical to flattened, elongated, and kidney-shaped. Pods are of various shades of green, yellow, red, and purple and splashed with red or purple; pod shapes range from flat to round, smooth to irregular, and straight to sharply curved; length ranges from 75 to 200 millimetres (3 to 8 inches) or more.

The common bean of Central and South American origin (*Phaseolus vulgaris*) is second to the soybean in importance. It is called French bean, haricot bean, and kidney bean in various countries; in the United States, however, kidney bean refers to a specific type that is definitely kidney-shaped and red, dark

red, or white. Some varieties of common bean are grown only for the dry seeds, some only for the edible immature pods, and others for the seeds, either immature or mature. Brazil, China, and the United States produce more than a third of the world's supply of this bean in the mature state. This bean figures prominently in Latin-American and Creole cuisines.

Third in importance, the principal bean of Europe though little known in the United States, is the Windsor, or broad, bean (*Vicia faba*). The broad bean will not tolerate hot weather; it is grown in summer only in the cool parts of the temperate zone and during the winter in the warmer parts. Unlike other beans described, it tolerates slight freezing. The plant is erect, from 600 to 1,500 mm tall, and bears few branches; the stem and branches are crowded with short-petioled leaves; the pods are nearly erect in clusters in the axils of the leaves; the seeds are large and irregularly flattened.

Most edible-podded beans can be grown over wide ranges of territory if they are planted at suitable times. The edible-podded varieties are popular in many countries, especially in Europe. In the United States the predominant edible-podded bean is the common string, snap, or green bean (*P. vulgaris*).

Of Central American origin, the lima bean (*P. limensis*) is of commercial importance in few countries outside the Americas. Grown only for food, dry mature lima beans constitute approximately 2½ percent of the total dry-bean production in the United States. There is a wide range of pod size and shape and of seed size, shape, thickness, and colour in both bush and climbing forms. Pods are wide, flat, and slightly curved. The lima bean is readily distinguished by the characteristic fine ridges in the seed coat that radiate from the "eye." A perennial in the tropics, elsewhere it is normally grown as an annual; it requires a longer season and warmer weather than most varieties of common American bean.

The scarlet runner bean (*P. coccineus*) is native to tropical America. Naturally a perennial, it is grown to a small extent in temperate climates as an annual. It is a vigorous climbing plant with showy racemes of scarlet flowers, large, coarse pods, and large, coloured seeds. The scarlet runner bean is grown in Great Britain and Europe for the attractive flowers and fleshy immature pods.

The mung bean, or green gram (*P. aureus*), is native to India. The pods and seeds are by far the smallest of any of the beans named here. The pods are slender, 75–100 mm long, and contain 10–14 spherical-to-oblong seeds about 3 mm in diameter. Extensively grown in the Orient for food, as bean sprouts and otherwise, the mung bean is little known in Europe and the Americas except for the preparation of sprouts. In this form the beans are a good source of vitamin C.

The horse gram (*Dolichos biflorus*) and the bonavist bean, native to India, are related, large, tropical climbing plants, the immature seeds of which are commonly used for food in Asia. The dry seeds are large, dark to black, nearly round to slightly flattened and elongated.

**Bean, Alan L(aVern)** (b. March 15, 1932, Wheeler, Texas, U.S.), astronaut, participant in the Apollo 12 mission (Nov. 14–22, 1969), in which two long walks, totalling nearly eight hours, were made on the Moon's surface. Bean and Comdr. Charles Conrad, Jr., piloted the Lunar Module to a pinpoint landing on the Moon, while astronaut Richard F. Gordon, Jr., orbited overhead in the Command Module.

Bean entered the U.S. Navy upon graduation (1955) from the University of Texas, Austin, and served as a test pilot before entering the manned spaceflight program in 1963. In addition to the Apollo 12 mission, Bean was



commander of the Skylab 3 mission (July 28–Sept. 25, 1973), during which he, Owen K. Garriott, and Jack R. Lousma formed the second crew to occupy the orbiting laboratory.



Bean, 1969

By courtesy of the National Aeronautics and Space Administration

Bean retired from the Navy in 1975 but remained with the National Aeronautics and Space Administration as chief of the astronaut candidate operations and training group.

**Bean, Roy** (b. 1825?, Mason County, Ky., U.S.—d. March 16, 1903, Langtry, Texas), justice of the peace and saloonkeeper who styled himself the “law west of the Pecos.”

For much of his life from the time he left his Kentucky home in 1847, Bean moved from town to town—in Mexico, Southern California, New Mexico, and Texas—getting into and fleeing from one scrape after another, killing at least two men in duels. During the Civil War he first served with Confederate regulars and then was a blockade runner in Texas, becoming so prosperous that he could live married in San Antonio for some 16 years at ease. In 1882 he moved on, west of the Pecos River, and set up a saloon, the Jersey Lilly, next to a railroad line through Dead Man’s Canyon. He named the site Langtry (after the actress Lillie Langtry) and eventually established himself as justice of the peace, with the approval of the Texas Rangers. He knew neither law nor court procedure and became celebrated for his rulings, which were variously hard, common-sensical, and prankish; he once reportedly fined a dead man \$40 for carrying a concealed weapon and pocketed the proceeds.

**bear**, large carnivore of the family Ursidae, closely related to the dog (family Canidae) and raccoon (Procyonidae). The bear is the most recently evolved of carnivores. Its ancestral line appears to have diverged from canid stock during the Miocene and to have developed, through such forms as the Pliocene *Hyaenarcos* (of Europe, Asia, and North America), into modern types such as the black and brown bear (*Ursus*).

Generally massive and short legged, bears vary in size from the smallest sun bear (27–46 kilograms [59–80 pounds]) to the huge Alaskan brown bear (see grizzly bear), which attains a weight of 780 kg. Despite this bulkiness, most bears climb with ease and swim strongly. They walk with their soles on the ground in plantigrade fashion, as does man, with the heel touching the ground. Each foot has five digits, ending in nonretractile claws (sometimes particularly adapted for digging, as in the sloth bear).

Lengthening of the canine teeth, reduction or absence of the first three premolars, and modifications for crushing with the molars (broad and flat crowned) characterize ursid dentition, completed with typical incisors. Bears constitute a generally omnivorous family, but individual dietary preferences range from seals for the extremely carnivorous polar bear to vegetative materials for the largely herbivorous spectacled bear; most bears enjoy honey. Usu-

ally gaining weight beforehand, a bear often sleeps fitfully through much of the winter; this long slumber, however, does not constitute true hibernation. Bears in the wild live from 15 to 30 years. The life span in captivity is considerably longer.

The bear may be hunted for trophy value or for its various economic assets, hides for clothes or rugs and meat and fat for food. Local names, derived particularly from their geographic locations, abound for these bears (the more usual equivalents are in the column on the right):

local and occasional names	more common names
American bear	black bear
Andean bear	spectacled bear
moon bear	Asiatic black bear
bhalu	sloth bear
brown bear	brown bear or black bear
bruang	sun bear
cinnamon bear	black bear
Himalayan bear	Asiatic black bear
ice bear	polar bear
Japanese bear	brown bear
Malay bear	sun bear
Mongolian bear	brown bear
sea bear	polar bear
Siberian bear	brown bear
silvertip	grizzly bear
Tibetan bear	brown bear or Asiatic black bear
water bear	polar bear
white bear	polar bear

**Bear Flag Revolt** (June–July 1846), short-lived independence rebellion precipitated by American settlers in California’s Sacramento Valley against Mexican authorities. In 1846 approximately 500 Americans were living in California, compared with between 8,000 and 12,000 Mexicans. Nonetheless, early in June a group of about a dozen Americans seized a large herd of horses from a Mexican military commandant. On June 14 another group captured Sonoma, the chief settlement north of San Francisco. Led by William B. Ide, the Americans issued a declaration of independence and hoisted a flag, its white ground emblazoned with a grizzly bear facing a red star. On June 25 Capt. John Charles Frémont arrived at Sonoma and gave his support to the Bear Flag Revolt. And on July 5 the insurrectionists elected Frémont to head the “Republic of California.”

But the Republic was quick to fall. On July 9 forces under Commodore John D. Sloat occupied San Francisco and Sonoma, claimed California for the United States, and replaced the bear flag with the American flag.

**bear grass**, also called **TURKEY BEARD**, one of two species of North American plants comprising the genus *Xerophyllum* of the lily family (Liliaceae). The western species, *X. tenax*, also is known as elk grass, squaw grass, and fire lily. It is a smooth, light-green mountain perennial with a stout, unbranched stem, from 0.6 to 2 metres (2 to 6 feet) high, which rises from a woody, tuber-like rootstock and cordlike roots. The stem bears a dense basal tuft of narrow, grasslike, rough-edged leaves, about one metre long; the leaves of the upper part of the stem are similar but much smaller. Flowering occurs at five to seven years. The top of the stem develops a large cluster of many small, creamy white flowers.

The turkey beard (*X. asphodeloides*) of southern North America is a similar plant that grows in dry pine barrens. In the southern and southwestern United States the name bear grass is given to various kinds of yucca, especially to *Yucca filamentosa* and *Y. glauca*; also to the camas (*Camassia scilloides*) and the aloelike *Dasylyrin texanum*, all of which have grasslike leaves.

**bear market**, in securities and commodities trading, a declining market. A bear is an in-

vestor who expects prices to decline and, on this assumption, sells a borrowed security or commodity in the hope of buying it back later at a lower price, a speculative transaction called selling short. The term bear may derive from the proverb about “selling the bearskin before one has caught the bear” or perhaps from selling when one is “bare” of stock. *Compare* bull market.

**bearbaiting**, alternatively **BULLBAITING**, the setting of dogs on a bear or a bull chained to a stake by the neck or leg. Held from the 12th to the 19th century, when they were banned as inhumane, these spectacles were usually staged at theatre-like arenas popularly called bear gardens.

In England many large groups of bears were kept expressly for the purpose. For a baiting attended by Queen Elizabeth I in 1575, 13 bears were provided.

When a bull was baited, its nose was often blown full of pepper to further arouse it. Specially trained dogs were loosed singly, each attempting to seize the tethered animal’s nose. Often, a hole in the ground was provided into which the bull might thrust this vulnerable part. A successful dog was said to have pinned



Bearbaiting, a miniature from the Luttrell Psalter, English, c. 1340; in the British Library

By courtesy of the trustees of the British Library

the bull. Some of the variations of these activities included whipping a blinded bear and baiting a pony with an ape tied to its back. Dogfighting and cockfighting were often provided as companion diversions.

A sport called bull-running also developed in some places, usually as an annual affair. The townspeople, armed with clubs, chased a bull until all were exhausted; then the bull was killed.

Baiting and its variations declined, although very slowly, from the late 17th century onward, the sports having been banned in England by the Puritans during the Civil Wars and Commonwealth (1642–60). The spectacles were permanently outlawed by act of Parliament in 1835.

Allied activities had scattered revivals on the U.S. frontier; typical examples included dogs being matched against badgers, or a chained bull being matched against a grizzly bear. In each case the battle ended when one killed the other. As U.S. frontiers disappeared, these pastimes disappeared as well.

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**bearberry**, also called **KINNIKINNICK** (*Arctostaphylos uva-ursi*), flowering, prostrate, evergreen shrubs, of the heath family (Ericaceae), occurring widely throughout North America in rocky and sandy woods and open areas. It has woody stems that are often 1.5–1.8 metres (5–6 feet) long. Roots develop from the stem joints, and the plant spreads, forming a broad, massive ground cover. The foliage turns bronzy in winter. The leaf margins are

rolled and fringed with hairs. The flowers, which may be white, pink, or pink-tipped in



Bearberry (*Arctostaphylos uva-ursi*) showing (top) flowers, (bottom) berries

(Top) Ingmar Holmasen, (bottom) Joan E. Rahn—EB Inc.

colour, are in the shape of a narrow-mouthed bell. The berries are red.

**Beard, Charles A(ustin)** (b. Nov. 27, 1874, near Knightstown, Ind., U.S.—d. Sept. 1, 1948, New Haven, Conn.), American historian, best-known for his iconoclastic studies of the development of U.S. political institutions. His emphasis on the dynamics of socioeconomic conflict and change and his analysis of motivational factors in the founding of institutions made him one of the most influential American historians of his time.

Reared in a prosperous family, Beard attended De Pauw University, Greencastle, Ind., and after his graduation in 1898 he studied at the University of Oxford. In 1899 he helped found a workingmen's school in Oxford. He visited the United States briefly in 1900, when he married Mary Ritter, returned to England, and permanently returned to the United States

in 1904 to teach political science at Columbia University.

Beard subsequently became one of the intellectual leaders of the Progressive movement and of American liberalism. He was a leader in movements seeking improvements in municipal government and administration and in national planning. He was initially interested in European history, and he collaborated with J.H. Robinson in writing several widely used textbooks on that subject. He then developed a schema of historical explanation that found its most famous expression in *An Economic Interpretation of the Constitution of the United States* (1913). In this book he claimed that the Constitution had been formulated by interest groups whose motivations were just as much personal financial ones as they were political ones. Although American politicians were generally outraged at the implications of material interests embodied in the Constitution by the Founding Fathers, the book was received by academicians as an innovative study on motivational factors among socioeconomic groups. In *The Economic Origins of Jeffersonian Democracy* (1915), Beard placed somewhat more emphasis on the philosophical context of political struggles, but he nevertheless reaffirmed his view of the importance of economic interests in governmental action. Beard and his wife, Mary R. Beard, subsequently produced a monumental synthesis of the history of the United States entitled *The Rise of American Civilization*, 2 vol. (1927). This widely acclaimed work was supplemented by two more volumes, *America in Midpassage* (1939) and *The American Spirit* (1942).

In 1917 Beard resigned from Columbia University in protest against the investigation and dismissal of several faculty members on charges of disloyalty and subversion. He was a cofounder of the New School for Social Research in New York City in 1919. His intellectual orientation in the next years began to shift toward the problem of historical knowledge, which occupied him during the early 1930s. Beard pointed out the subjective nature of the historian's selection and arrangement of facts on the basis of his own relationship to contemporary thought.

In the 1930s and '40s Beard's interests turned to the history of U.S. foreign policy. In 1934 he began writing a series of books and articles in which he attacked President Franklin D. Roosevelt's foreign policy. In such books as *American Foreign Policy in the Making, 1932–1940* (1946) and *President Roosevelt and the Coming of War, 1941* (1948), he charged Roosevelt with virtually maneuvering the United States into war with Japan. Beard was criticized as an isolationist because of these views, and his reputation declined somewhat after the publication of his last works, but he is still considered to be one of the most influential American historians of the 20th century.

**BIBLIOGRAPHY.** Thomas C. Kennedy, *Charles A. Beard and American Foreign Policy* (1975); Elias Berg, *The Historical Thinking of Charles A. Beard* (1957); Richard Hofstadter, *The Progressive Historians: Turner, Beard, Parrington* (1968, reprinted 1979); and Ellen Nore, *Charles Beard, an Intellectual Biography* (1983).

**beard grass:** see bluestem.

**beard lichen**, any member of the genus *Usnea*, a yellow or greenish fruticose (bushy, branched) lichen with long stems and disk-shaped holdfasts, which resembles a tangled mass of threads. It occurs in both the Arctic and the tropics, where it is eaten by wild animals or collected as fodder. In the past it was used as a remedy for whooping cough, catarrh, epilepsy, and dropsy. It has been used also as an astringent, a tonic, and a diuretic. Old-man's-beard (*U. barbata*) was first described in 300 BC as a hair-growth stimulant. Hanging moss (*U. longissima*) looks like gray threads about 1.5 m (5 feet) long hanging from



Old-man's-beard (*Usnea barbata*)

Louise K. Broman—Root Resources

tree branches in humid, mountainous regions. Some species of *Usnea* also produce an orange dye. It is the "beard moss," or "tree moss," of the poets and Shakespeare's "idle moss." It is sometimes confused with the plant known as Spanish moss, which is similar in appearance but is unrelated to lichens.

**bearded seal** (*Erignathus barbatus*), nonmigratory seal of the family Phocidae, distinguished by the bushy, bristly whiskers for which it is named; it is also known as "square-flipper" after the rectangular shape of the foreflipper. Highly valued by Eskimos for its hide, meat, and blubber, the bearded seal is a grayish or yellow-brown animal that lives alone or in small groups in coastal Arctic waters. It attains a length of about 2.4–3.7 m (8–12 feet) and a weight of about 225–454 kg (500–1,000 pounds); the female is somewhat smaller than the male. An adept diver, the bearded seal feeds mainly on clams and other bottom animals, possibly using its whiskers to scrape for prey. The female breeds every other year, bearing a single dark-gray pup after about 11 months' gestation.

**bearded tit** (bird): see reedling.

**bearded vulture:** see lammergeier.

**Bearden, Romare (Howard)** (b. Sept. 2, 1914, Charlotte, N.C., U.S.—d. March 11, 1988, New York City), American painter whose collages of photographs and painted paper on canvas depict aspects of American black culture in a style derived from Cubism.

Bearden studied at the Art Students League in New York City with George Grosz (1936–37) and at Columbia University (1943). His early paintings were realistic and often religious in theme (e.g., "The Annunciation," 1942). After military service during World War II, he lived in Paris (1950–51), studied at the Sorbonne, and traveled extensively in Europe. During this period he developed his mature, semiabstract collage style. He first achieved recognition in the mid-1940s, and by the 1960s he had come to be regarded as the preeminent collagist in the United States.

The narrative structure of Bearden's paintings is simple and archetypal; ritual, music, and family are his pervasive themes. His works' complexity lies in their poetic abstraction, in which layered fragments of colour and pattern evoke the rhythms, textures, and mysteries of a people's experience (e.g., in "Family," 1969).

**beardfish**, any of the five species of fishes in the genus *Polymixia* constituting the family Polymixiidae (order Beryciformes). Beardfishes are restricted primarily to deep-sea marine habitats in tropical and temperate regions of the Atlantic and Pacific oceans.



Beard, 1917

By courtesy of the Library of Congress, Washington, D.C.



They generally are found at depths from about 200 to 600 metres (650 to 2,000 feet). The term beardfish comes from the beardlike appearance of two enlarged barbels that extend downward from the chin region. Beardfishes are not particularly large; the widely distributed stout beardfish (*P. nobilis*) attains a length of less than 20 centimetres (8 inches).

**Beardmore Glacier**, glacier in central Antarctica, descending about 7,200 ft (2,200 m) from the South Polar Plateau to Ross Ice Shelf, dividing the Transantarctic Mountains of Queen Maud and Queen Alexandra. One of the world's largest known valley glaciers, it is 125 mi (200 km) long and is 25 mi in width. The British explorers Ernest Henry Shackleton (1908) and Robert Scott (1911) discovered the glacier on their route to the South Pole. Later scientific research found the glacier to contain petrified wood and fossils of ferns and coral, evidence of a time when Antarctica possessed a temperate climate.

**Beardsley, Aubrey (Vincent)** (b. Aug. 21, 1872, Brighton, Sussex, Eng.—d. March 16, 1898, Menton, Fr.), the leading English illustrator of the 1890s and, after Oscar Wilde, the outstanding figure in the Aestheticism movement.

Drawing was a strong interest from early childhood, and Beardsley continued with it while earning his living as a clerk. A meeting with the English artist Sir Edward Burne-Jones in 1891 led to his attending evening classes at the Westminster School of Art for a few months—his only professional instruction.

In 1893 he was commissioned to illustrate a new edition of Sir Thomas Malory's *Morte Darthur*, and in 1894 he was appointed art editor and illustrator of a new quarterly, *The Yellow Book*. His illustrations for Oscar Wilde's play *Salomé* (1894) won him widespread notoriety. He was greatly influenced by the elegant, curvilinear style of Art Nouveau (q.v.) and the bold sense of design found in Japanese woodcuts. But what startled critics and public alike was the obvious sensuality of the women in his drawings, which usually contained an element of morbid eroticism. This tendency became pronounced in his openly licentious illustrations to Aristophanes' *Lysistrata* (1896). Although Beardsley was not homosexual and was quite outside the scandals surrounding Wilde, he was dismissed from *The Yellow Book* in the general revulsion against Aestheticism that followed Wilde's exposure in 1895. He then became principal illustrator of an-

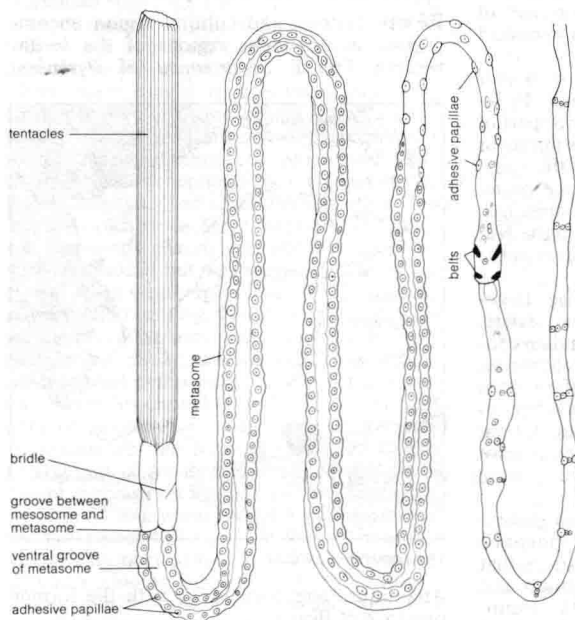
other new magazine, *The Savoy*, and he illustrated numerous books, including Alexander Pope's *Rape of the Lock* (1896). During this period he also wrote some poems and a prose parody, *Under the Hill* (1903; the original unexpurgated version, *The Story of Venus and Tannhauser*, appeared in 1907).

Delicate in health from the age of six, when he first contracted tuberculosis, he was attacked again by the disease when he was 17. From 1896 he was an invalid. In 1897, after being received into the Roman Catholic Church, he went to live in France, where he died at the age of 25. His work enjoyed periodic revivals, most notably during the 1960s.

**beardworm**, also called **POGONOPHORAN**, any of a group of marine invertebrates constituting the phylum Pogonophora. Pogonophorans live a sedentary life in long, protective tubes on seafloors throughout the world. The common name beardworm refers to the beardlike mass of pinnate (feather-like) tentacles borne

by the free or fused tentacles, intermesh to form a filter. Beside each pinnule base is a ciliary tract. In each intertentacular region, ciliary tracts produce a current of water that carries in microorganisms and other nutrients; these are filtered through the pinnule filter. Digestive enzymes probably are secreted by gland cells located at the pinnule bases. Water leaves by an opening at the base of certain tentacles. The digested food may be absorbed by the pinnules. The pinching off of small food particles in the outer layers of the pinnules during a process known as pinocytosis also has been observed. Direct penetration of amino acids from sea-water into the tentacles also has been reported to take place.

Reproduction is sexual. Eggs, which have a high yolk content, are laid by the female in the anterior part of the tube, in which fertil-



Female *Spirobrachia beklemischevi*, ventral view with posterior one-sixth of trunk not shown

From A.V. Ivanov, *Zoologische Jahrbucher Abt. 1 Systematik*, 85 (1957); Gustav Fischer Verlag

at the anterior end of many species. An intestine, which forms in embryos, disappears as development progresses. Males of the phylum are generally similar in appearance to females. Pogonophorans are the only multicellular animals that have neither mouth nor anus.

Pogonophorans were first classified as a distinct phylum in the middle of the 20th century. The first species, *Siboglinum weberi*, described in 1914, came from the seas of the Malayan Archipelago; the second species, *Lamellisabella zachsi*, which came from the Okhotsk Sea, was described in 1933. In 1937 a new class called Pogonophora was established for *Lamellisabella*. In 1955 a close affinity between *Siboglinum* and *Lamellisabella* was proved, and the members were placed in the newly established phylum Pogonophora.

Pogonophorans usually inhabit marine waters to depths that exceed 1,000 metres (32,800 feet); some species have been found at depths ranging from 7,000 to 10,000 metres. A native population inhabits the trenches of the Pacific and the Indian oceans. Many genera have a discontinuous distribution.

**Natural history.** The tentacles, probably used during feeding, vary in number according to body size. The tentacles are long processes containing blood vessels and are continuous with the body cavity, or coelom. Rows of very thin single-celled units called pinnules are found on the tentacles. The pinnules, which extend into the intertentacular cavity formed

ization and early development to formation of a swimming larva also occur. Cleavage leads to the formation of a bilaterally symmetrical embryo. A cell layer called the endoderm first is represented by a few yolk-rich cells, which form a primary intestine; the intestine disappears as the yolk is utilized. Both mouth and anus fail to develop. A secondary body cavity is formed by separation of coelomic pockets from the primary intestine. The embryo develops into a larva having two ciliary belts and three body segments.

**Form and function.** The wormlike body varies in length from several centimetres to 0.5 metre (1.64 feet), the body diameter, from 0.06 millimetre to 4 millimetres (0.002 inch to 0.16 inch). *Lamellibrachia barhami* is one of the largest species. The body consists of three segments: two small anterior regions are called protosome and mesosome; the long trunk section is called the metasome. Each segment has its own coelom. The small protosome bears tentacles. The mesosome contains a structure known as a bridle, also called a frenulum, a pair of oblique cuticular ridges that extend backward to meet in the midventral line. The bridle supports the protruding worm on the edge of its tube. The metasome is divided into two sections by a pair of parallel ridges called belts; these have rows of small platelets containing minute teeth. One part of the metasome, in front of the belts, has a groove bordered by low folds.



"A Footnote," self-portrait, drawing by Aubrey Beardsley, 1896