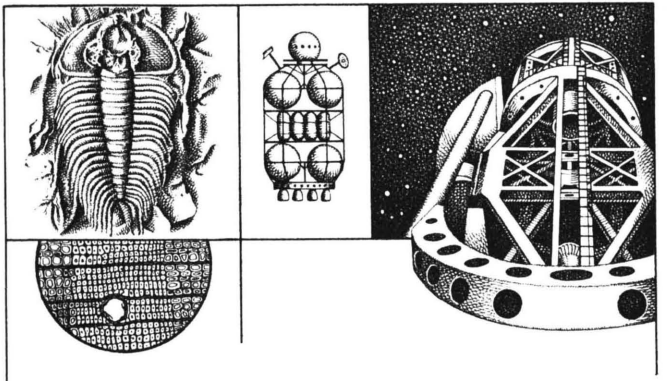
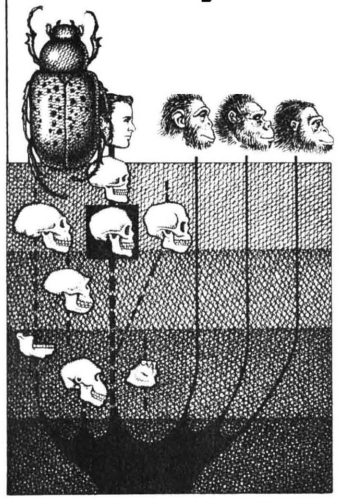
Galaxy
SCIENCE FICTION

JANUARY 1956
35¢



for your information



By WILLY LEY

FYR GREGEYS AND WYLDE-FYR

REPEATEDLY, IN the past, I have had whole columns devoted exclusively to themes provoked by letters from my readers. This is another of these columns and the first theme I want to take up is that of "Greek Fire."

Earlier this year, I received a letter from a reader in which I was asked whether anything is known about the composition of "Greek Fire." My correspondent wrote that a book printed in 1850

— presumably in England — asserted that some statements about the feats and attributes of mythological and semi-mythological characters could probably be explained by the assumption that the hero used Greek Fire, "the composition of which is now lost."

I replied that I could not judge the mythological implications (about which I feel somewhat doubtful), but that the composition of Greek Fire had never been lost and that it was certainly known in 1850, although the author of the book quoted evidently had not known where to look for it.

He could, for example, have consulted the work "On Greek Fire" which *Monsieur le professeur* Reynaud and *le Capitaine* Favé had published in Paris in 1845. He could have found something about it in earlier English books on gunnery. He could even have come across *fyr gregeys* (Greek Fire) and the allied *wylde-fyr* (wildfire) in still older English romances.

AS THESE two names, of which one has become proverbial, indicate, there were two types: Greek Fire, which came first and was used on land for sieges as well as at sea in naval engagements, and wildfire, which came several centuries later and was used exclusively at sea, as far as we know, at any rate.

That this later wildfire or sea-fire was promptly called Greek Fire, too — especially by people who were not Greek themselves — produced the first stumbling block of confusion. And for a long time there actually existed a well-kept secret about the sea-fire. The existence of such a secret was loudly advertised ("secret weapons" were everybody's favorite even in antiquity) and it is probably this much-mentioned fact that led to later generalizations about a "lost art."

As regards the early Greek Fire, we have not only general and possibly exaggerated descriptions of its effectiveness but even an actual recipe. It was written about 350 B. C. by Aeneas the Tactician.

Greek Fire, he said, consists of sulphur, pitch, incense, pine-wood and tow. No proportions being given, it is easy to see that the mixture ratio of the ingredients was by no means critical. The incense probably had some religious significance. As for the pine-wood, a later commentator thought that the term actually meant charcoal from pine-wood, but personally I can't see any reason for this interpretation. Resinous pine-wood, probably whittled into shavings, sounds like a very logical companion for sulphur and pitch.

Aeneas went on to say that this mixture was put into egg-shaped wooden containers and heaved upon the decks of enemy ships after ignition. My guess is that these containers were purposely made weak to burst open upon striking.

The next preserved recipe for Greek Fire is just seven centuries younger than the one just quoted, having been written down in 350 A.D. It can be found in *De Re Militari* by Vegetius. That the seven centuries had improved the mixture by way of much practice of "premeditated military arson" (to use the circumlocution of some German historians for the employment of incendiaries) can be seen from the list of ingredients.

They were sulphur, rosin, bitumen and naphtha — a mixture which would stump even well-drilled modern firefighters if they had nothing but water at their disposal to combat the blaze.

Actually the Greek Fire of Vegetius was a much better incendiary than the Greek Fire of the much later collection of military recipes that goes under the name of *Liber ignium*, or "Fire Book."

THE RECIPE for Greek Fire is one of the oldest in the "Fire Book," which dates it at around 1200 A. D. The ingredients listed are the usual sulphur and pitch, to which petroleum and *sarcocolla* (a tree gum) were added. Further ingredients were something called Oil of Gemma, *tartarum* or cream of tartar and *sal coctus*, which is salt produced by the evaporation of sea water.

The *sal coctus* especially could not have done anything for the mixture but slow down combustion and one may be tempted to guess at some magical reason for its presence. However, the military historian S. J. von Romocki has pointed out that there may have been a rational reason involved, rational though mistaken.

Salt from the sea is essentially ordinary salt with a good dose of "impurities" and when you add salt to a fire the flame is colored yellow because of the sodium in the salt. Colonel von Romocki had reason to believe that the people of the eleventh century thought that a brighter flame was also a hotter flame and since the salt brightened the fire, it was thought to be a useful addition. It may even have been a trade secret for a long time.

The real and useful secret I mentioned earlier came into being about midway in time between the straightforward recipe of Vegetius and the far more complicated and less effective one of the *Liber ignium*. The secret was in the hands of the Christian emperors of Constantinople, who

confused many a later high-school boy by their habit of referring to themselves as "Romans." In the printed editions of their own writings, it *is* strange to see somebody proclaim in Greek type that "we Romans" did this or that.

But aside from this minor item, everything is clear and logical. The *Chronography of Theophanes,* written 811-815 A. D., states in so many words that in 673 the architect Kallinikos fled from Heliopolis in Syria "to the Romans" (read: Constantinople) and compounded a sea-fire which enabled those Romans to burn a large number of Moslem ships at Cyzicus during the first Moslem siege of Constantinople.

The emperor, Constantine (VII) Porphyrogenetos, himself corroborated the story by writing: "Be it known that under the reign of Constantine Pogonatos one Kallinikos, who fled from Heliopolis to the Romans, prepared a wet-fire to be discharged from siphons, by means of which the Romans burned the fleet of the Saracens at Cyzicus and gained the victory."

Since the reign of emperor Constantine Pogonatos lasted from 668 to 685, the flight of Kallinikos probably did take place in 673. This was just one year before the beginning of the first siege of Constantinople, which lasted from 674 to 676. Because of this close proximity of the dates, it seems likely that Kallinikos did not make his invention after his arrival in Constantinople but brought the secret with him. It must have been his own and not just something known in Heliopolis, because the other side never learned it.

EMPEROR CONSTANTINE Porphyrogenetos still kept a certain amount of "security" on his best weapon, for he advised his son as follows: "If any persons venture to inquire of you how this fire is prepared, withstand them, and dismiss them with some such answer as this: that the secret was revealed by an angel to the first Emperor Constantine."

The first Constantine ruled from 323 to 337 and was, of course, completely innocent of the whole case, but some later historians, reading the passage inattentively, took it seriously and tried to push events back by more than three centuries. But as the British Lt.-Col. Henry W. L. Hime remarked about the seventh Constantine's advice to his son: "this passage merely proves that the Emperor was mendacious and his people superstitious."

The wet-fire or sea-fire — later called wildfire — did serve the "Romans" well. It won the naval battle which lifted the first siege

of Constantinople for them and it did the same in the second siege in 716 to 718. It repulsed a Russian fleet under Igor in 941 and won them a decisive victory when the Russians tried again in 1043.

What was this substance?

That the secret of Kallinikos was the incorporation of saltpeter into "ordinary" Greek Fire seemed an irresistable conclusion to quite a number of later writers, especially those who had no first-hand experience with black gunpowder. The reason for their belief was that one of the original sources on sea-fire, the book of Princess Anna Komnena, mentions that it burned with much smoke and a thunderous noise, something that oil vapor can do nicely.

What the "saltpeter writers" overlooked or did not understand were several simple facts. Emperor Constantine Porphyrogenetos as well as Anna Komnena emphasize that the sea-fire was projected from wooden siphons and we can get an idea of what a siphon was if we know that this word ordinarily means the apparatus with which water was thrown into a conflagration. Because of this method of projecting it, the sea-fire must have been a liquid. It is stated furthermore that it burned on the surface of the water and if you throw slow-burning gunpowder into water you don't get any result worth mentioning — few substances are as sensitive to moisture as black gunpowder.

Moreover, if the Byzantine "procurement service" — whatever its proper name may have been — had bought large quantities of an entirely novel substance, namely saltpeter, this could not have stayed a secret for any length of time. It had to be something that did not arouse curiosity because it was well known and used for other purposes, too. And it had to be something that would sustain combustion in spite of the sea water and even *cause* combustion with the aid of the water.

AT ABOUT the time the architect Kallinikos left Heliopolis to join "the Romans," an improvement on the well-known Greek Fire had taken place. Pliny the Elder, living in Rome in the first century A. D., already knew that quicklime, when wetted, produces a temperature high enough to ignite easily inflammable substances such as naptha.

Around the year 500, a recipe for a quicklime-asphalt mixture for military uses in sieges and such was actually written down, advising the artisan to prepare this mixture "in the heat of the noonday sun." Two such recipes can still be found in the *Liber ignium* — one names sulphur, quicklime and turpentine, the

other substitutes oil for the turpentine — and another book of the same period contains a recipe listing sulphur, quicklime, naptha, wax and oil.

But quicklime could not have been the secret of Kallinikos. In the first place, it was not a secret in his time. In the second place, a rather large quantity of quicklime is needed to produce ignition of an inflammable substance, more quicklime than could be pumped through a fire hose. There is little doubt that the liquid directed at the enemy through the "siphon" was a mixture of petroleum, oil and naphtha, but what ignited it?

No satisfactory answer to that question was given until about 1912, when the English professor W. R. E. Hodgkinson of the Ordnance College in Woolwich got in touch with his compatriot Henry W. L. Hime after having read the latter's book on the origin of gunpowder and ammunition. Professor Hodgkinson pointed out that there is a substance which could ignite such an incendiary liquid at sea even when present in only small quantities.

This substance is phosphide of calcium. It not only meets the technical requirements but also what might be called the historical requirements. It would have been a novel substance at the time, known only to the man who happened to stumble across it. It could have been kept secret because rather small quantities were required and because no unusual materials were needed to make it. It can be made of lime, bones and urine, all three inconspicuous and all three much used by alchemists for their experiments.

In a manner of speaking, the secret of the sea-fire is still a secret, for nobody seems to ever have written it down. But Professor Hodgkinson's suggestion can be accepted as the solution of the problem without any reservations. Calcium phosphide was not "known," but could have been found by dabbling in alchemy.

Quite likely, several people came across it at one time or another. Kallinikos, however, could visualize a use for it when he did.

THE BITE OF THE SHREW

THE NEXT question, from a reader in Canada, is about as far removed thematically from the earlier question as is possible, but there is one connecting link — it, too, is prompted by a statement in an old book.

An explorer, returning from Africa, wrote that he had been assured by Ethiopians as well as white settlers that the claws of lions were poisonous, for wounds

caused by such claws tended to "inflame" and to be very slow-healing, often breaking open again months later.

My correspondent concluded correctly that the idea — accepting the statement itself as being substantially true — was based on a confusion between poison and infection. But he wanted to know whether any vertebrates other than snakes and the two versions of the Gila monster actually carry poison.

The answer is not as simple as it might look at first glance. Among the amphibians, for example, there is no known case of poison glands connected with hollow or grooved fangs, which is what one usually thinks of after a mention of venomous snakes. But various toads produce a substance in skin glands that can raise blisters on human skin. There is no real danger and susceptibility seems to vary within fantastic limits, most people having very little of it. But strictly speaking, it is a poison.

And one South American tree frog, beautifully sheathed in shiny green and golden-yellow skin, does produce a poison in its skin glands which makes it dangerous to the touch. The South American Indians actually use the frog's skin exudation to poison their arrows.

In the classes above the amphibians and reptiles, examples of poison become so rare that they are surprises rather than examples and even a zoologist may not think at once of the one I have chiefly in mind. True, there is no venomous bird, although somebody once spoke of "the hawk's venomous glare," but it is different with the mammals. One whole group of them has glands producing a strongly venomous substance, even though this is not possibly a weapon.

I AM REFERRING to the members of the lowest subclass of the mammals, the monotremes of Australia and New Guinea, better known as platypus and echidna.

The males of these animals carry on their hind legs a spur, rather similar in appearance and position to the spur of a rooster. It is smaller in size and, unlike the rooster's spur, it is movable. And it has a fine canal, so narrow that a human hair can be passed through it, while a horse hair is too thick. This canal is connected with the duct of a gland. And ever since platypus has been known — which is since 1797 — it was said that the spur is poisonous.

One very precise report was written in 1816 by Sir John Jamison. A man, he reported, had picked up a male platypus and the animal, kicking its legs, had

jabbed its spur into his hand. The victim "in spite of immediate medical treatment exhibited all the symptoms of a person bitten by a venomous snake. The man was obliged to keep to his bed for several days, and did not recover the use of his hand for nine weeks."

This is the first definite case on record, but it did not remain the only one. In the course of time, quite a number of people have been injured by the spur of a male platypus and in every case the symptoms resembled snake bite, though recovery, as a rule, took less than a week. No fatal case is known, but smaller animals, like rabbits, died very soon after a platypus spur was forced through their skins.

I said earlier that this cannot possibly be a weapon because only the males are equipped with the spur. It must somehow be sex-linked, but so far very little about its "natural use" — if this is the proper term — is known. The two most obvious theories that have found their way into print are that (A) the spurs are the equivalent of antlers and used by the males on each other in fighting for the females or (B) the spurs are used by the males on the females to inject them with what to a platypus is an aphrodisiac. Maybe — but to anybody else, it is poison.

Another example of a poison gland in a mammal has become known only very recently. It was announced for the first time during the last week of 1954 of the First International Conference on Animal Venoms by Dr. Oliver P. Pearson of the University of California.

The poison bearer is the short-tailed shrew *Blarina brevicauda*. The poison glands seem to be "in a distinctive, granule-filled segment" of the tissue around the jaws. "Injection of minute quantities of saline extract of these glands produces dramatic effects on respiration, pulse and blood pressure" in experimental animals. It kills mice, which the shrew eats. It has been found in this species of shrew only.

And that is all that is known so far.

LEAP YEARS ON MARS

ANOTHER CANADIAN reader, an officer of the armed forces, came up with a triple question, all concerning our neighbor Mars. His third and last question is the easiest to answer — where should he try to be stationed in 1956, when Mars comes close, so he can get a good view?

Well, *not* in Canada and if an assignment of that sort can be wangled, south of even the U. S.

The second question was just

how close Mars would be during the 1956 opposition and how this opposition compares to a few of the preceding oppositions. The answer is that the 1956 opposition comes close to what is astronomically possible; it is a pity that we can't observe it from a space station outside the Earth's atmosphere.

The next really good opposition will take place in August, 1971, and there should be a space station by then. There will be a fine one in 2003, but with some luck we'll then no longer need oppositions to observe the planet; very likely one will be able to call up the *Lacus Solis* station and inquire about the local weather forecast.

As for comparisons with other recent oppositions, this is how things worked out:

1939, July 23	36,171,000
1941, Oct. 10	38,508,000
1943, Dec. 5	50,599,000
1946, Jan. 14	59,800,000
1948, Feb. 18	63,000,000
1950, March 24	60,700,000
1952, May 2	52,400,000
1954, June 25	40,300,000
1956, Sept. 11	35,400,000

The first question in the letter was whether somebody had ever devised a calendar for Mars. To my knowledge, it has been done at least three times. The earliest I know of came from the facile pen of the French astronomer Camille Flammarion. Some ten or twelve years ago, Dr. Robert S. Richardson presented several versions of a Martian calendar and last year Dr. I. M. Levitt published another one, modeled, no doubt, on the proposed World Calendar for Earth.

The sad fact is that Mars, just like Earth, does not complete one revolution around the Sun in a fractionless number of its days. The length of the Martian year is 668 *and six-tenths* Martian days. This produces something like the leap-year cycle of the terrestrial calendar, except that there are more leap years than normal years on Mars, if you define a leap year as a year that has one more day than a normal year.

In Dr. Levitt's calendar, the Martian year is divided into four equal quarters, running 56, 56, 55. This means that the first two months of the quarter, say January and February, have 56 days each, while March has 55. The same holds true for each quarter in turn. The total per year makes 668 days. To take care of the extra 6/10th of a day per year, the calendar has to run in five-year cycles.

In each cycle, you have two normal years of 668 days and three leap years of 669 days. In those leap years, December would have 56 days, too. Now twice 668 plus three times 669 adds up to

3343 days. The figure 668.6 multiplied by five also produces 3343 days. Trouble is that the true figure is not 668.6 but 668.59905, so that each calendar year comes out just a trifle too long.

However, the problem can be simply solved, since the tiny difference adds up to just one day per millenium. Once every millenium, a day has to be dropped, which means that in one five-year cycle per millenium, there will be three normal years and two leap years.

LAST WORD ON THE "MOUNTAIN BOOMER"

EVERY ONCE in a while, I have the pleasing experience of receiving a letter which tells me something instead of asking questions. Such a letter came from an officer of the U. S. Navy, who wrote:

"As a herpetologist and Texan, I can answer your question as to the use of Mountain Boomer for lizards of the genus *Crotaphytus*. Oddly enough, its origin is tied up with the strange life history of the frog *Eleuthrodactylus latrans* (family *Leptodactylidae*). This is a fairly common but seldom seen frog of the southwestern United States. Unlike most other frogs and toads, the frogs of this genus do not require water for their larval development.

"The eggs are laid in the moist earth under large boulders and slabs of limestone. Here the tadpoles develop and undergo metamorphosis before hatching. Tiny frogs emerge directly from the eggs. The mating call of an adult male can be heard over a half a mile, and unlike other frogs they call throughout the day as well as night. Now with the underside of boulders the favorite habitat of *Eleuthrodactylus latrans* and the upper surfaces the favorite sunning places of *Crotaphytus collaris* (and other large lizards), it often happens that the loud boom of the frog is attributed to the basking lizard.

"I first heard," my correspondent continued, "the Collared Lizard called Mountain Boomer a number of years ago while on a field trip near San Marcos, Texas. Upon asking why such a strange name, I was assured that the lizard had a mighty voice and boomed both day and night. My informant then described perfectly the voice of *Eleuthrodactylus latrans* . . . Of course, almost all lizards are mute, with a few exceptions, like some members of the family *Geckonidae* and the Jamaican lizard *Anolis grahami*, which emit a faint squeak."

Thank you, Mr. R. E. We'll now put the Mountain Boomer to rest as far as this column is concerned.

— WILLY LEY

From the desk of:

H. L. GOLD

To Our Readers:

This is your Christmas Issue! From now on Galaxy will go on sale much earlier than usual. We are going to establish a five week prior to cover date; "on-sale date". In order to do this we are redating our covers, therefore, we are not publishing an issue marked December. However, your January issue is the Christmas number. Subscribers will get their full number of copies and all readers can look for Galaxy on the stands the last week of each month, (ie) January issue on sale last week of November, February issue on sale last week of December, etc. We hope you like this new dating.

Galaxy publishing corporation