In [2]:
```
pip install plotly
```

```
Requirement already satisfied: plotly in c:\users\lenovo\anaconda3\envs\python3\lib\site-packages (5.16.1)Note:
you may need to restart the kernel to use updated packages.

Requirement already satisfied: tenacity>=6.2.0 in c:\users\lenovo\anaconda3\envs\python3\lib\site-packages (fro
m plotly) (8.2.3)
Requirement already satisfied: packaging in c:\users\lenovo\appdata\roaming\python\python311\site-packages (fro
m plotly) (23.0)
```

In [3]:
```
pip install scikit-image
```

```
Requirement already satisfied: scikit-image in c:\users\lenovo\anaconda3\envs\python3\lib\site-packages (0.21.0
)
Requirement already satisfied: numpy>=1.21.1 in c:\users\lenovo\anaconda3\envs\python3\lib\site-packages (from
scikit-image) (1.24.3)
Requirement already satisfied: scipy>=1.8 in c:\users\lenovo\anaconda3\envs\python3\lib\site-packages (from sci
kit-image) (1.10.1)
Requirement already satisfied: networkx>=2.8 in c:\users\lenovo\anaconda3\envs\python3\lib\site-packages (from
scikit-image) (3.1)
Requirement already satisfied: pillow>=9.0.1 in c:\users\lenovo\anaconda3\envs\python3\lib\site-packages (from
scikit-image) (9.4.0)
Requirement already satisfied: imageio>=2.27 in c:\users\lenovo\anaconda3\envs\python3\lib\site-packages (from
scikit-image) (2.31.1)
Requirement already satisfied: tifffile>=2022.8.12 in c:\users\lenovo\anaconda3\envs\python3\lib\site-packages
(from scikit-image) (2023.7.4)
Requirement already satisfied: PyWavelets>=1.1.1 in c:\users\lenovo\anaconda3\envs\python3\lib\site-packages (f
rom scikit-image) (1.4.1)
Requirement already satisfied: packaging>=21 in c:\users\lenovo\appdata\roaming\python\python311\site-packages
(from scikit-image) (23.0)
Requirement already satisfied: lazy_loader>=0.2 in c:\users\lenovo\anaconda3\envs\python3\lib\site-packages (fr
om scikit-image) (0.3)
Note: you may need to restart the kernel to use updated packages.
```

In [4]:
```python
import cv2
import numpy as np
from matplotlib import pyplot as plt
from scipy import ndimage
from skimage import measure, color, io

import plotly
import plotly.express as px
import plotly.graph_objects as go
from skimage import data, filters, measure, morphology
from skimage import data
from skimage.color import rgb2gray
```

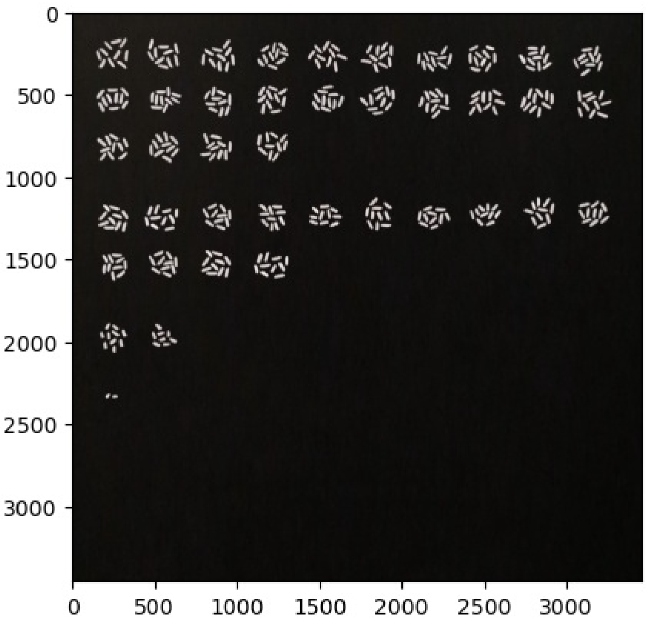
In [ ]:
```

```

Sample1 Rice Grade 100%

In [5]:
```python
Img_Sample1 = cv2.imread("D:\\Test_Al\\Images_Datasets\\02_Testing_images\\Sample1\\Sample1.jpg")
```

In [6]:
```python
plt.imshow(Img_Sample1)
```

Out[6]:
```
<matplotlib.image.AxesImage at 0x2d7839c3f50>
```

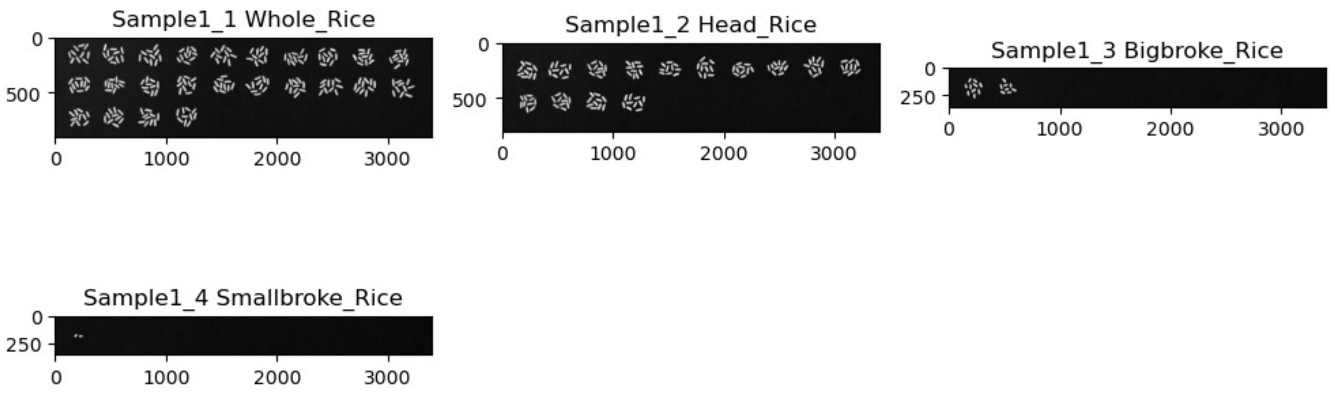


In [7]:
```python
Img_Sample1_1 = cv2.imread("D:\\Test_Al\\Images_Datasets\\02_Testing_images\\Sample1\\Sample1_1.jpg")
```

In [7]:
```
Img_Sample1_1 = cv2.imread("D:\\Test_AI\\Images_Datasets\\02_Testing_images\\Sample1\\Sample1_1.jpg")
Img_Sample1_2 = cv2.imread("D:\\Test_AI\\Images_Datasets\\02_Testing_images\\Sample1\\Sample1_2.jpg")
Img_Sample1_3 = cv2.imread("D:\\Test_AI\\Images_Datasets\\02_Testing_images\\Sample1\\Sample1_3.jpg")
Img_Sample1_4 = cv2.imread("D:\\Test_AI\\Images_Datasets\\02_Testing_images\\Sample1\\Sample1_4.jpg")
```

In [8]:
```
Img_Sample1_1_Gray=rgb2gray(Img_Sample1_1)
Img_Sample1_2_Gray=rgb2gray(Img_Sample1_2)
Img_Sample1_3_Gray=rgb2gray(Img_Sample1_3)
Img_Sample1_4_Gray=rgb2gray(Img_Sample1_4)
```

In [9]:
```
# Create a figure with subplots to display the images
plt.figure(figsize=(10, 4))


# Display the second image sample
plt.subplot(2, 3, 1)
plt.imshow(Img_Sample1_1_Gray, cmap='gray')
plt.title('Sample1_1 Whole_Rice')

# Display the third image sample
plt.subplot(2, 3, 2)
plt.imshow(Img_Sample1_2_Gray, cmap='gray')
plt.title('Sample1_2 Head_Rice')

# Display the fourth image sample
plt.subplot(2, 3, 3)
plt.imshow(Img_Sample1_3_Gray, cmap='gray')
plt.title('Sample1_3 Bigbroke_Rice')

# Display the fourth image sample
plt.subplot(2, 3, 4)
plt.imshow(Img_Sample1_4_Gray, cmap='gray')
plt.title('Sample1_4 Smallbroke_Rice')

# Adjust spacing between subplots
plt.tight_layout()

# Show the plot
plt.show()
```



In [10]:
```
# Apply Otsu's thresholding to each image
threshold_Img_Sample1_1 = filters.threshold_otsu(Img_Sample1_1_Gray)
threshold_Img_Sample1_2 = filters.threshold_otsu(Img_Sample1_2_Gray)
threshold_Img_Sample1_3 = filters.threshold_otsu(Img_Sample1_3_Gray)
threshold_Img_Sample1_4 = filters.threshold_otsu(Img_Sample1_4_Gray)
```

In [11]:
```
# Sample1_1
img_mask_Sample1_1 = Img_Sample1_1_Gray > threshold_Img_Sample1_1
img_mask_Sample1_1 = morphology.remove_small_objects(img_mask_Sample1_1, 15)
img_mask_Sample1_1 = morphology.remove_small_holes(img_mask_Sample1_1, 15)

# Sample1_2
img_mask_Sample1_2 = Img_Sample1_2_Gray > threshold_Img_Sample1_2
img_mask_Sample1_2 = morphology.remove_small_objects(img_mask_Sample1_2, 15)
img_mask_Sample1_2 = morphology.remove_small_holes(img_mask_Sample1_2, 15)

# Sample1_3
img_mask_Sample1_3 = Img_Sample1_3_Gray > threshold_Img_Sample1_3
img_mask_Sample1_3 = morphology.remove_small_objects(img_mask_Sample1_3, 15)
img_mask_Sample1_3 = morphology.remove_small_holes(img_mask_Sample1_3, 15)

# Sample1_4
img_mask_Sample1_4 = Img_Sample1_4_Gray > threshold_Img_Sample1_4
img_mask_Sample1_4 = morphology.remove_small_objects(img_mask_Sample1_4, 15)
img_mask_Sample1_4 = morphology.remove_small_holes(img_mask_Sample1_4, 15)
```

In [12]:
```
img_labels_Sample1_1 = measure.label(img_mask_Sample1_1)
img_labels_Sample1_2 = measure.label(img_mask_Sample1_2)
img_labels_Sample1_3 = measure.label(img_mask_Sample1_3)
img_labels_Sample1_4 = measure.label(img_mask_Sample1_4)
```

Sample1_1

In [15]:

```
import pandas as pd
import numpy as np
from skimage.measure import regionprops, regionprops_table

props_Sample1_1 = regionprops_table(img_labels_Sample1_1, properties=('area', 'major_axis_length', 'minor_axis_

# Create empty lists to store property values
equiv_diameters = []
aspect_ratios = []
compactnesses = []
roundnesses = []
categories = []


for idx, region in enumerate(regionprops(img_labels_Sample1_1)):
    # Calculate properties for each region
    equiv_diameter = np.sqrt(4 * region.area / np.pi)
    aspect_ratio = region.major_axis_length / region.minor_axis_length
    compactness = (region.perimeter ** 2) / (4 * np.pi * region.area)
    roundness = (4 * region.area) / (np.pi * (region.major_axis_length ** 2))

    # Append the calculated values to the respective lists
    equiv_diameters.append(equiv_diameter)
    aspect_ratios.append(aspect_ratio)
    compactnesses.append(compactness)
    roundnesses.append(roundness)
    categories.append('Whole Rice')

# Create a dictionary with all the properties
props_Sample1_1 = {
    'area': props_Sample1_1['area'],
    'major_axis_length': props_Sample1_1['major_axis_length'],
    'minor_axis_length': props_Sample1_1['minor_axis_length'],
    'perimeter': props_Sample1_1['perimeter'],
    'eccentricity': props_Sample1_1['eccentricity'],
    'solidity': props_Sample1_1['solidity'],
    'extent': props_Sample1_1['extent'],
    'equiv_diameter': equiv_diameters,
    'aspect_ratio': aspect_ratios,
    'compactness': compactnesses,
    'roundness': roundnesses,
    'category': categories,
}

# Create a DataFrame from the dictionary
df_Sample1_1 = pd.DataFrame(props_Sample1_1)
```

In [16]:

```
df_Sample1_1
```

Out[16]:

	area	major_axis_length	minor_axis_length	perimeter	eccentricity	solidity	extent	equiv_diameter	aspect_ratio	compactness
0	1101.0	71.653909	19.921369	158.409163	0.960575	0.954073	0.433977	37.441110	3.596837	1.813691
1	1170.0	68.740281	21.902982	158.468037	0.947878	0.957447	0.600000	38.596506	3.138398	1.707999
2	1176.0	68.096447	22.625869	158.468037	0.943187	0.947623	0.602151	38.695345	3.009672	1.699285
3	1211.0	69.127190	22.634081	158.994949	0.944877	0.958828	0.472125	39.266947	3.054120	1.661165
4	1356.0	74.134883	23.791050	170.994949	0.947108	0.950245	0.481534	41.551328	3.116083	1.715920
...	...	...	...	...	...	...	...	...	...	...
235	1060.0	68.443411	20.158612	152.409163	0.955642	0.947274	0.440199	36.737364	3.395244	1.743839
236	1204.0	70.446099	22.423973	158.911688	0.947985	0.946541	0.729697	39.153294	3.141553	1.669073
237	953.0	61.146389	20.155013	138.752309	0.944114	0.961655	0.464878	34.833853	3.033805	1.607599
238	976.0	66.261010	18.980184	146.994949	0.958096	0.959685	0.436494	35.251692	3.491063	1.761754
239	1288.0	72.144466	23.261936	166.166522	0.946591	0.960477	0.479881	40.496080	3.101396	1.705930

240 rows × 12 columns

In [ ]:

Sample1_2

In [17]:

```python
import pandas as pd
import numpy as np
from skimage.measure import regionprops, regionprops_table

props_Sample1_2 = regionprops_table(img_labels_Sample1_2, properties=('area', 'major_axis_length', 'minor_axis_

# Create empty lists to store property values
equiv_diameters = []
aspect_ratios = []
compactnesses = []
roundnesses = []
categories = []


for idx, region in enumerate(regionprops(img_labels_Sample1_2)):
    # Calculate properties for each region
    equiv_diameter = np.sqrt(4 * region.area / np.pi)
    aspect_ratio = region.major_axis_length / region.minor_axis_length
    compactness = (region.perimeter ** 2) / (4 * np.pi * region.area)
    roundness = (4 * region.area) / (np.pi * (region.major_axis_length ** 2))

    # Append the calculated values to the respective lists
    equiv_diameters.append(equiv_diameter)
    aspect_ratios.append(aspect_ratio)
    compactnesses.append(compactness)
    roundnesses.append(roundness)
    categories.append('Head Rice')

# Create a dictionary with all the properties
props_Sample1_2 = {
    'area': props_Sample1_2['area'],
    'major_axis_length': props_Sample1_2['major_axis_length'],
    'minor_axis_length': props_Sample1_2['minor_axis_length'],
    'perimeter': props_Sample1_2['perimeter'],
    'eccentricity': props_Sample1_2['eccentricity'],
    'solidity': props_Sample1_2['solidity'],
    'extent': props_Sample1_2['extent'],
    'equiv_diameter': equiv_diameters,
    'aspect_ratio': aspect_ratios,
    'compactness': compactnesses,
    'roundness': roundnesses,
    'category': categories,
}

# Create a DataFrame from the dictionary
df_Sample1_2 = pd.DataFrame(props_Sample1_2)
```

In [18]:

```python
df_Sample1_2
```

Out[18]:

	area	major_axis_length	minor_axis_length	perimeter	eccentricity	solidity	extent	equiv_diameter	aspect_ratio	compactness	r
0	936.0	58.142131	20.788439	133.012193	0.933896	0.972973	0.835714	34.521764	2.796849	1.504171	
1	1138.0	69.101559	21.436271	152.894444	0.950667	0.958719	0.447327	38.065031	3.223581	1.634674	
2	1028.0	68.191315	19.560026	153.480231	0.957978	0.943119	0.426910	36.178588	3.486259	1.823484	
3	969.0	65.380499	19.268812	146.409163	0.955584	0.947214	0.425186	35.125050	3.393074	1.760366	
4	881.0	57.191350	19.915174	133.775649	0.937413	0.953463	0.584218	33.492149	2.871747	1.616473	
...	...	...	...	...	...	...	...	...	...	...	
135	1035.0	58.536112	22.874793	138.852814	0.920484	0.961003	0.537942	36.301555	2.558979	1.482379	
136	1038.0	63.962143	21.139914	146.325902	0.943804	0.948812	0.676662	36.354128	3.025658	1.641479	
137	1063.0	63.015974	21.789443	146.124892	0.938317	0.957658	0.558298	36.789314	2.892042	1.598473	
138	1201.0	73.138918	21.379942	161.497475	0.956321	0.950158	0.828847	39.104484	3.420913	1.728139	
139	1176.0	68.833246	22.029453	157.639610	0.947404	0.950687	0.623873	38.695345	3.124601	1.681564	

140 rows × 12 columns

In [ ]:

Sample1_3

In [19]:

```python
import pandas as pd
```

In [19]:

```
import pandas as pd
import numpy as np
from skimage.measure import regionprops, regionprops_table

props_Sample1_3 = regionprops_table(img_labels_Sample1_3, properties=('area', 'major_axis_length', 'minor_axis_

# Create empty lists to store property values
equiv_diameters = []
aspect_ratios = []
compactnesses = []
roundnesses = []
categories = []


for idx, region in enumerate(regionprops(img_labels_Sample1_3)):
    # Calculate properties for each region
    equiv_diameter = np.sqrt(4 * region.area / np.pi)
    aspect_ratio = region.major_axis_length / region.minor_axis_length
    compactness = (region.perimeter ** 2) / (4 * np.pi * region.area)
    roundness = (4 * region.area) / (np.pi * (region.major_axis_length ** 2))

    # Append the calculated values to the respective lists
    equiv_diameters.append(equiv_diameter)
    aspect_ratios.append(aspect_ratio)
    compactnesses.append(compactness)
    roundnesses.append(roundness)
    categories.append('Big Broke')

# Create a dictionary with all the properties
props_Sample1_3 = {
    'area': props_Sample1_3['area'],
    'major_axis_length': props_Sample1_3['major_axis_length'],
    'minor_axis_length': props_Sample1_3['minor_axis_length'],
    'perimeter': props_Sample1_3['perimeter'],
    'eccentricity': props_Sample1_3['eccentricity'],
    'solidity': props_Sample1_3['solidity'],
    'extent': props_Sample1_3['extent'],
    'equiv_diameter': equiv_diameters,
    'aspect_ratio': aspect_ratios,
    'compactness': compactnesses,
    'roundness': roundnesses,
    'category': categories,
}

# Create a DataFrame from the dictionary
df_Sample1_3 = pd.DataFrame(props_Sample1_3)
```

In [20]:

```
df_Sample1_3
```

Out[20]:

	area	major_axis_length	minor_axis_length	perimeter	eccentricity	solidity	extent	equiv_diameter	aspect_ratio	compactness	rou
0	724.0	45.984950	20.622768	115.740115	0.893799	0.951380	0.583871	30.361578	2.229815	1.472378	0
1	840.0	48.985597	22.496999	120.852814	0.888303	0.954545	0.525328	32.703535	2.177428	1.383644	0
2	792.0	48.554685	21.275503	117.195959	0.898889	0.962333	0.536585	31.755405	2.282187	1.380035	0
3	872.0	49.772152	23.145382	127.396970	0.885297	0.939655	0.587205	33.320637	2.150414	1.481125	0
4	886.0	56.716183	20.352259	133.438600	0.933398	0.953714	0.485746	33.587055	2.786727	1.599261	0
5	620.0	41.583309	19.707228	105.491378	0.880567	0.959752	0.776942	28.096415	2.110054	1.428343	0
6	674.0	41.535979	21.648180	110.740115	0.853440	0.945302	0.587108	29.294427	1.918682	1.447905	0
7	660.0	42.654483	20.431952	109.982756	0.877809	0.945559	0.582011	28.988586	2.087636	1.458463	0
8	781.0	49.894300	20.344990	121.497475	0.913088	0.951279	0.628824	31.534110	2.452412	1.504089	0
9	703.0	48.518636	18.866302	112.627417	0.921303	0.964335	0.867901	29.918011	2.571709	1.435896	0
10	682.0	41.075122	21.765609	108.911688	0.848062	0.949861	0.631481	29.467768	1.887157	1.384059	0
11	815.0	50.751859	21.162882	127.124892	0.908912	0.944380	0.519770	32.213200	2.398154	1.577952	0
12	865.0	49.900041	22.409457	122.710678	0.893488	0.961111	0.570204	33.186627	2.226740	1.385284	0
13	827.0	50.885025	21.291231	123.941125	0.908254	0.954965	0.733156	32.449485	2.389952	1.478140	0
14	780.0	46.537340	22.118587	117.941125	0.879831	0.945455	0.738636	31.513915	2.103992	1.419143	0
15	857.0	50.098845	22.047997	122.468037	0.897954	0.956473	0.600982	33.032806	2.272263	1.392691	0
16	651.0	46.059784	18.779369	111.455844	0.913108	0.943478	0.778708	28.790258	2.452680	1.518500	0
17	746.0	44.829007	21.542209	109.455844	0.876972	0.980289	0.888095	30.819421	2.080985	1.277995	0

In [ ]:

Sample1_4

In [21]:

```
import pandas as pd
import numpy as np
from skimage.measure import regionprops, regionprops_table

props_Sample1_4 = regionprops_table(img_labels_Sample1_4, properties=('area', 'major_axis_length', 'minor_axis_

# Create empty lists to store property values
equiv_diameters = []
aspect_ratios = []
compactnesses = []
roundnesses = []
categories = []


for idx, region in enumerate(regionprops(img_labels_Sample1_4)):
    # Calculate properties for each region
    equiv_diameter = np.sqrt(4 * region.area / np.pi)
    aspect_ratio = region.major_axis_length / region.minor_axis_length
    compactness = (region.perimeter ** 2) / (4 * np.pi * region.area)
    roundness = (4 * region.area) / (np.pi * (region.major_axis_length ** 2))

    # Append the calculated values to the respective lists
    equiv_diameters.append(equiv_diameter)
    aspect_ratios.append(aspect_ratio)
    compactnesses.append(compactness)
    roundnesses.append(roundness)
    categories.append('Small Broke')

# Create a dictionary with all the properties
props_Sample1_4 = {
    'area': props_Sample1_4['area'],
    'major_axis_length': props_Sample1_4['major_axis_length'],
    'minor_axis_length': props_Sample1_4['minor_axis_length'],
    'perimeter': props_Sample1_4['perimeter'],
    'eccentricity': props_Sample1_4['eccentricity'],
    'solidity': props_Sample1_4['solidity'],
    'extent': props_Sample1_4['extent'],
    'equiv_diameter': equiv_diameters,
    'aspect_ratio': aspect_ratios,
    'compactness': compactnesses,
    'roundness': roundnesses,
    'category': categories,
}

# Create a DataFrame from the dictionary
df_Sample1_4 = pd.DataFrame(props_Sample1_4)
```

In [22]:

```
df_Sample1_4
```

Out[22]:

	area	major_axis_length	minor_axis_length	perimeter	eccentricity	solidity	extent	equiv_diameter	aspect_ratio	compactness	rounc
0	516.0	34.941465	19.055662	89.154329	0.838202	0.957328	0.616487	25.631847	1.833653	1.225816	0.5
1	523.0	35.207074	19.279400	91.698485	0.836740	0.944043	0.769118	25.805121	1.826150	1.279419	0.5

In [ ]:

Combine

In [23]:

```
csv_file_path = 'Sample1_1.csv'
df_Sample1_1.to_csv(csv_file_path, index=False)
print(f"Data has been exported to {csv_file_path}") # print a message to confirm the export

csv_file_path = 'Sample1_2.csv'
df_Sample1_2.to_csv(csv_file_path, index=False)
print(f"Data has been exported to {csv_file_path}") # print a message to confirm the export

csv_file_path = 'Sample1_3.csv'
df_Sample1_3.to_csv(csv_file_path, index=False)
print(f"Data has been exported to {csv_file_path}") # print a message to confirm the export

csv_file_path = 'Sample1_4.csv'
df_Sample1_4.to_csv(csv_file_path, index=False)
print(f"Data has been exported to {csv_file_path}") # print a message to confirm the export
```

```
Data has been exported to Sample1_1.csv
Data has been exported to Sample1_2.csv
Data has been exported to Sample1_3.csv
Data has been exported to Sample1_4.csv
```

In [24]:

```
import pandas as pd

# List of CSV file names
csv_files = [
    "Sample1_1.csv",
    "Sample1_2.csv",
    "Sample1_3.csv",
    "Sample1_4.csv",
]

# Create an empty DataFrame to store the combined data
combined_prop_data = pd.DataFrame()

# Loop through the CSV files and append their data to the combined_data DataFrame
for file in csv_files:
    df = pd.read_csv(file)  # Read each CSV file
    combined_prop_data = combined_prop_data.append(df, ignore_index=True)  # Append data to the combined DataFr

# Save the combined data to a new CSV file
combined_prop_data.to_csv("Sample1_Data.csv", index=False)
```

```
C:\Users\LENOVO\AppData\Local\Temp\ipykernel_9256\3599681874.py:17: FutureWarning: The frame.append method is d
eprecated and will be removed from pandas in a future version. Use pandas.concat instead.
  combined_prop_data = combined_prop_data.append(df, ignore_index=True)  # Append data to the combined DataFram
e
C:\Users\LENOVO\AppData\Local\Temp\ipykernel_9256\3599681874.py:17: FutureWarning: The frame.append method is d
eprecated and will be removed from pandas in a future version. Use pandas.concat instead.
  combined_prop_data = combined_prop_data.append(df, ignore_index=True)  # Append data to the combined DataFram
e
C:\Users\LENOVO\AppData\Local\Temp\ipykernel_9256\3599681874.py:17: FutureWarning: The frame.append method is d
eprecated and will be removed from pandas in a future version. Use pandas.concat instead.
  combined_prop_data = combined_prop_data.append(df, ignore_index=True)  # Append data to the combined DataFram
e
C:\Users\LENOVO\AppData\Local\Temp\ipykernel_9256\3599681874.py:17: FutureWarning: The frame.append method is d
eprecated and will be removed from pandas in a future version. Use pandas.concat instead.
  combined_prop_data = combined_prop_data.append(df, ignore_index=True)  # Append data to the combined DataFram
e
```

In [25]:

```
Sample1_Data = pd.read_csv("Sample1_Data.csv")
```

In [26]:

```
Sample1_Data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 400 entries, 0 to 399
Data columns (total 12 columns):
 #   Column             Non-Null Count  Dtype  
---  ------             --------------  -----  
 0   area               400 non-null    float64
 1   major_axis_length  400 non-null    float64
 2   minor_axis_length  400 non-null    float64
 3   perimeter          400 non-null    float64
 4   eccentricity       400 non-null    float64
 5   solidity           400 non-null    float64
 6   extent             400 non-null    float64
 7   equiv_diameter     400 non-null    float64
 8   aspect_ratio       400 non-null    float64
 9   compactness        400 non-null    float64
 10  roundness          400 non-null    float64
 11  category           400 non-null    object 
dtypes: float64(11), object(1)
memory usage: 37.6+ KB
```

In [27]:

```
Sample1_Data
```

Out[27]:

	area	major_axis_length	minor_axis_length	perimeter	eccentricity	solidity	extent	equiv_diameter	aspect_ratio	compactness	r
0	1101.0	71.653909	19.921369	158.409163	0.960575	0.954073	0.433977	37.441110	3.596837	1.813691	
1	1170.0	68.740281	21.902982	158.468037	0.947878	0.957447	0.600000	38.596506	3.138398	1.707999	
2	1176.0	68.096447	22.625869	158.468037	0.943187	0.947623	0.602151	38.695345	3.009672	1.699285	
3	1211.0	69.127190	22.634081	158.994949	0.944877	0.958828	0.472125	39.266947	3.054120	1.661165	
4	1356.0	74.134883	23.791050	170.994949	0.947108	0.950245	0.481534	41.551328	3.116083	1.715920	
...	...	...	...	...	...	...	...	...	...	...	
395	857.0	50.098845	22.047997	122.468037	0.897954	0.956473	0.600982	33.032806	2.272263	1.392691	
396	651.0	46.059784	18.779369	111.455844	0.913108	0.943478	0.778708	28.790258	2.452680	1.518500	
397	746.0	44.829007	21.542209	109.455844	0.876972	0.980289	0.888095	30.819421	2.080985	1.277995	
398	516.0	34.941465	19.055662	89.154329	0.838202	0.957328	0.616487	25.631847	1.833653	1.225816	
399	523.0	35.207074	19.279400	91.698485	0.836740	0.944043	0.769118	25.805121	1.826150	1.279419	

400 rows × 12 columns

In [49]:

```
unique_categories = Sample1_Data['category'].unique()
print(unique_categories)
```

```
['Whole Rice' 'Head Rice' 'Big Broke' 'Small Broke']
```

In [28]:

```
#####################     Sample1: CSV file is Sample1_Data.csv     #####################
```

In [ ]:

```
```

Sample 2 Rice Grade 5%

In [29]:

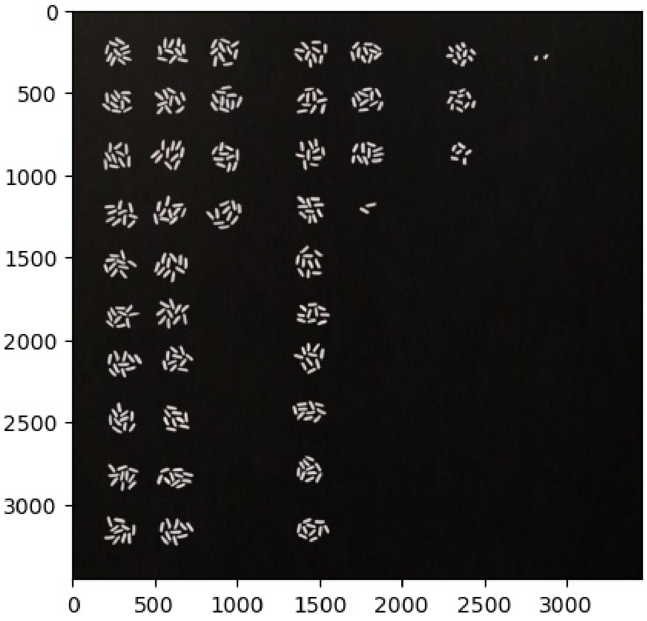
```
Img_Sample2 = cv2.imread("D:\\Test_Al\\Images_Datasets\\02_Testing_images\\Sample2\\Sample2.jpg")
```

In [30]:

```
plt.imshow(Img_Sample2)
```

Out[30]:

```
<matplotlib.image.AxesImage at 0x2d7841fcc90>
```



In [31]:

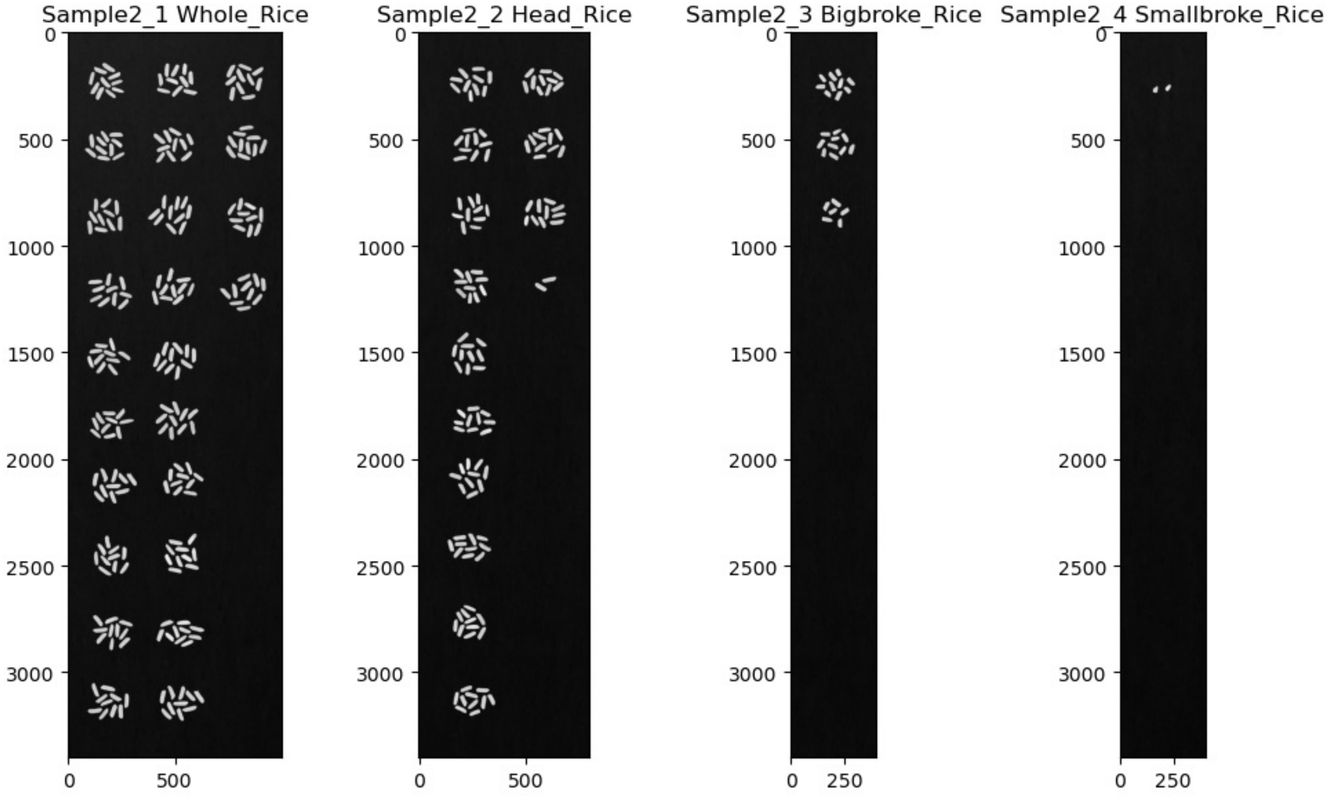
```
Img_Sample2_1 = cv2.imread("D:\\Test_Al\\Images_Datasets\\02_Testing_images\\Sample2\\Sample2_1.jpg")
Img_Sample2_2 = cv2.imread("D:\\Test_Al\\Images_Datasets\\02_Testing_images\\Sample2\\Sample2_2.jpg")
Img_Sample2_3 = cv2.imread("D:\\Test_Al\\Images_Datasets\\02_Testing_images\\Sample2\\Sample2_3.jpg")
Img_Sample2_4 = cv2.imread("D:\\Test_Al\\Images_Datasets\\02_Testing_images\\Sample2\\Sample2_4.jpg")
```

In [32]:

```
Img_Sample2_1_Gray=rgb2gray(Img_Sample2_1)
Img_Sample2_2_Gray=rgb2gray(Img_Sample2_2)
Img_Sample2_3_Gray=rgb2gray(Img_Sample2_3)
Img_Sample2_4_Gray=rgb2gray(Img_Sample2_4)
```

In [33]:

```
# Create a figure with subplots to display the images
plt.figure(figsize=(10, 6))


# Display the second image sample
plt.subplot(1, 4, 1)
plt.imshow(Img_Sample2_1_Gray, cmap='gray')
plt.title('Sample2_1 Whole_Rice')

# Display the third image sample
plt.subplot(1, 4, 2)
plt.imshow(Img_Sample2_2_Gray, cmap='gray')
plt.title('Sample2_2 Head_Rice')

# Display the fourth image sample
plt.subplot(1, 4, 3)
plt.imshow(Img_Sample2_3_Gray, cmap='gray')
plt.title('Sample2_3 Bigbroke_Rice')

# Display the fourth image sample
plt.subplot(1, 4, 4)
plt.imshow(Img_Sample2_4_Gray, cmap='gray')
plt.title('Sample2_4 Smallbroke_Rice')

# Adjust spacing between subplots
plt.tight_layout()

# Show the plot
plt.show()
```



In [34]:

```
threshold_Img_Sample2_1 = filters.threshold_otsu(Img_Sample2_1_Gray)
threshold_Img_Sample2_2 = filters.threshold_otsu(Img_Sample2_2_Gray)
threshold_Img_Sample2_3 = filters.threshold_otsu(Img_Sample2_3_Gray)
threshold_Img_Sample2_4 = filters.threshold_otsu(Img_Sample2_4_Gray)
```

In [35]:

```
# Sample2_1
img_mask_Sample2_1 = Img_Sample2_1_Gray > threshold_Img_Sample2_1
img_mask_Sample2_1 = morphology.remove_small_objects(img_mask_Sample2_1, 15)
img_mask_Sample2_1 = morphology.remove_small_holes(img_mask_Sample2_1, 15)

# Sample2_2
img_mask_Sample2_2 = Img_Sample2_2_Gray > threshold_Img_Sample2_2
img_mask_Sample2_2 = morphology.remove_small_objects(img_mask_Sample2_2, 15)
img_mask_Sample2_2 = morphology.remove_small_holes(img_mask_Sample2_2, 15)

# Sample2_3
img_mask_Sample2_3 = Img_Sample2_3_Gray > threshold_Img_Sample2_3
img_mask_Sample2_3 = morphology.remove_small_objects(img_mask_Sample2_3, 15)
img_mask_Sample2_3 = morphology.remove_small_holes(img_mask_Sample2_3, 15)

# Sample2_4
img_mask_Sample2_4 = Img_Sample2_4_Gray > threshold_Img_Sample2_4
img_mask_Sample2_4 = morphology.remove_small_objects(img_mask_Sample2_4, 15)
img_mask_Sample2_4 = morphology.remove_small_holes(img_mask_Sample2_4, 15)
```

In [36]:

```
img_labels_Sample2_1 = measure.label(img_mask_Sample2_1)
img_labels_Sample2_2 = measure.label(img_mask_Sample2_2)
img_labels_Sample2_3 = measure.label(img_mask_Sample2_3)
img_labels_Sample2_4 = measure.label(img_mask_Sample2_4)
```

In [ ]:

Sample2_1

In [37]:

```
import pandas as pd
import numpy as np
from skimage.measure import regionprops, regionprops_table

props_Sample2_1 = regionprops_table(img_labels_Sample2_1, properties=('area', 'major_axis_length', 'minor_axis_

# Create empty lists to store property values
equiv_diameters = []
aspect_ratios = []
compactnesses = []
roundnesses = []
categories = []


for idx, region in enumerate(regionprops(img_labels_Sample2_1)):
    # Calculate properties for each region
    equiv_diameter = np.sqrt(4 * region.area / np.pi)
    aspect_ratio = region.major_axis_length / region.minor_axis_length
    compactness = (region.perimeter ** 2) / (4 * np.pi * region.area)
    roundness = (4 * region.area) / (np.pi * (region.major_axis_length ** 2))

    # Append the calculated values to the respective lists
    equiv_diameters.append(equiv_diameter)
    aspect_ratios.append(aspect_ratio)
    compactnesses.append(compactness)
    roundnesses.append(roundness)
    categories.append('Whole Rice')  # Category 5 for Whole

# Create a dictionary with all the properties
props_Sample2_1 = {
    'area': props_Sample2_1['area'],
    'major_axis_length': props_Sample2_1['major_axis_length'],
    'minor_axis_length': props_Sample2_1['minor_axis_length'],
    'perimeter': props_Sample2_1['perimeter'],
    'eccentricity': props_Sample2_1['eccentricity'],
    'solidity': props_Sample2_1['solidity'],
    'extent': props_Sample2_1['extent'],
    'equiv_diameter': equiv_diameters,
    'aspect_ratio': aspect_ratios,
    'compactness': compactnesses,
    'roundness': roundnesses,
    'category': categories,
}

# Create a DataFrame from the dictionary
df_Sample2_1 = pd.DataFrame(props_Sample2_1)
```

In [38]:

```
df_Sample2_1
```

Out[38]:

	area	major_axis_length	minor_axis_length	perimeter	eccentricity	solidity	extent	equiv_diameter	aspect_ratio	compactness	r
0	1260.0	71.496582	22.703544	162.409163	0.948242	0.964778	0.477273	40.053487	3.149138	1.665868	
1	1104.0	67.751054	21.023568	150.669048	0.950637	0.970123	0.796537	37.492085	3.222624	1.636323	
2	948.0	58.390897	20.900842	133.254834	0.933742	0.961460	0.769481	34.742353	2.793710	1.490554	
3	1047.0	70.367938	19.187485	159.195959	0.962107	0.948370	0.481158	36.511393	3.667387	1.926227	
4	1148.0	66.868341	22.100976	152.610173	0.943801	0.963087	0.530009	38.231911	3.025583	1.614415	
...	...	...	...	...	...	...	...	...	...	...	
235	1190.0	72.033093	21.434382	163.639610	0.954702	0.955823	0.603448	38.924993	3.360633	1.790689	
236	1086.0	66.122660	21.314786	152.124892	0.946620	0.959364	0.548485	37.185187	3.102197	1.695746	
237	1193.0	70.393179	22.265468	158.083261	0.948659	0.941594	0.723030	38.974027	3.161540	1.666946	
238	974.0	66.297948	18.919205	145.580736	0.958419	0.962451	0.435599	35.215555	3.504267	1.731566	
239	1100.0	68.783242	20.815164	151.722871	0.953111	0.964912	0.431711	37.424103	3.304478	1.665327	

240 rows × 12 columns

In [ ]:

Sample2_2

In [39]:

```
import pandas as pd
import numpy as np
from skimage.measure import regionprops, regionprops_table

props_Sample2_2 = regionprops_table(img_labels_Sample2_2, properties=('area', 'major_axis_length', 'minor_axis_

# Create empty lists to store property values
equiv_diameters = []
aspect_ratios = []
compactnesses = []
roundnesses = []
categories = []


for idx, region in enumerate(regionprops(img_labels_Sample2_2)):
    # Calculate properties for each region
    equiv_diameter = np.sqrt(4 * region.area / np.pi)
    aspect_ratio = region.major_axis_length / region.minor_axis_length
    compactness = (region.perimeter ** 2) / (4 * np.pi * region.area)
    roundness = (4 * region.area) / (np.pi * (region.major_axis_length ** 2))

    # Append the calculated values to the respective lists
    equiv_diameters.append(equiv_diameter)
    aspect_ratios.append(aspect_ratio)
    compactnesses.append(compactness)
    roundnesses.append(roundness)
    categories.append('Head rice')  # Category 4 for Head

# Create a dictionary with all the properties
props_Sample2_2 = {
    'area': props_Sample2_2['area'],
    'major_axis_length': props_Sample2_2['major_axis_length'],
    'minor_axis_length': props_Sample2_2['minor_axis_length'],
    'perimeter': props_Sample2_2['perimeter'],
    'eccentricity': props_Sample2_2['eccentricity'],
    'solidity': props_Sample2_2['solidity'],
    'extent': props_Sample2_2['extent'],
    'equiv_diameter': equiv_diameters,
    'aspect_ratio': aspect_ratios,
    'compactness': compactnesses,
    'roundness': roundnesses,
    'category': categories,
}

# Create a DataFrame from the dictionary
df_Sample2_2 = pd.DataFrame(props_Sample2_2)
```

In [40]:

```
df_Sample2_2
```

Out[40]:

	area	major_axis_length	minor_axis_length	perimeter	eccentricity	solidity	extent	equiv_diameter	aspect_ratio	compactness	r
0	1003.0	64.672023	20.042389	141.941125	0.950766	0.970958	0.865401	35.735966	3.226762	1.598474	
1	1150.0	66.668501	22.284304	151.580736	0.942483	0.963956	0.479167	38.265199	2.991725	1.589938	
2	1005.0	60.713672	21.256516	137.580736	0.936708	0.968208	0.485507	35.771577	2.856238	1.498785	
3	970.0	62.187800	20.259230	140.183766	0.945447	0.945419	0.782889	35.143169	3.069603	1.612181	
4	1140.0	64.921915	22.838141	145.941125	0.936083	0.975192	0.904762	38.098466	2.842697	1.486759	
...	...	...	...	...	...	...	...	...	...	...	
127	989.0	57.693192	22.390693	139.539105	0.921618	0.948226	0.548835	35.485686	2.576660	1.566700	
128	1184.0	69.269758	22.159280	156.911688	0.947452	0.954839	0.717576	38.826738	3.125993	1.654813	
129	972.0	62.763678	19.880613	139.338095	0.948508	0.972000	0.470019	35.179381	3.157029	1.589511	
130	955.0	62.918164	19.879925	143.195959	0.948771	0.931707	0.496104	34.870385	3.164910	1.708631	
131	866.0	57.348706	19.654605	134.468037	0.939437	0.936216	0.547755	33.205804	2.917825	1.661538	

132 rows × 12 columns

In [ ]:

Sample2_3

In [41]:

```
import pandas as pd
import numpy as np
from skimage.measure import regionprops, regionprops_table

props_Sample2_3 = regionprops_table(img_labels_Sample2_3, properties=('area', 'major_axis_length', 'minor_axis_

# Create empty lists to store property values
equiv_diameters = []
aspect_ratios = []
compactnesses = []
roundnesses = []
categories = []


for idx, region in enumerate(regionprops(img_labels_Sample2_3)):
    # Calculate properties for each region
    equiv_diameter = np.sqrt(4 * region.area / np.pi)
    aspect_ratio = region.major_axis_length / region.minor_axis_length
    compactness = (region.perimeter ** 2) / (4 * np.pi * region.area)
    roundness = (4 * region.area) / (np.pi * (region.major_axis_length ** 2))
    # Append the calculated values to the respective lists
    equiv_diameters.append(equiv_diameter)
    aspect_ratios.append(aspect_ratio)
    compactnesses.append(compactness)
    roundnesses.append(roundness)
    categories.append('Big Broke')  # Category 3 for Big Broke

# Create a dictionary with all the properties
props_Sample2_3 = {
    'area': props_Sample2_3['area'],
    'major_axis_length': props_Sample2_3['major_axis_length'],
    'minor_axis_length': props_Sample2_3['minor_axis_length'],
    'perimeter': props_Sample2_3['perimeter'],
    'eccentricity': props_Sample2_3['eccentricity'],
    'solidity': props_Sample2_3['solidity'],
    'extent': props_Sample2_3['extent'],
    'equiv_diameter': equiv_diameters,
    'aspect_ratio': aspect_ratios,
    'compactness': compactnesses,
    'roundness': roundnesses,
    'category': categories,
}

# Create a DataFrame from the dictionary
df_Sample2_3 = pd.DataFrame(props_Sample2_3)
```

In [42]:

```
df_Sample2_3
```

Out[42]:

	area	major_axis_length	minor_axis_length	perimeter	eccentricity	solidity	extent	equiv_diameter	aspect_ratio	compactness	ro
0	664.0	37.938992	22.667306	102.225397	0.801893	0.958153	0.614815	29.076297	1.673732	1.252390	
1	951.0	55.232275	22.493587	129.923882	0.913315	0.956740	0.515447	34.797282	2.455468	1.412497	
2	713.0	47.588991	19.343941	112.953319	0.913660	0.959623	0.521199	30.130048	2.460150	1.423963	
3	842.0	48.794048	22.426294	119.095454	0.888120	0.972286	0.526250	32.742445	2.175752	1.340505	
4	866.0	53.755282	20.826861	127.497475	0.921896	0.960089	0.644345	33.205804	2.581055	1.493741	
5	931.0	55.971264	22.021700	137.811183	0.919348	0.940404	0.554167	34.429435	2.541641	1.623340	
6	834.0	47.523084	22.660397	115.698485	0.878996	0.981176	0.882540	32.586528	2.097187	1.277260	
7	699.0	41.470605	21.851751	105.882251	0.849914	0.961486	0.587395	29.832775	1.897816	1.276319	
8	672.0	39.957736	21.811188	102.811183	0.837879	0.965517	0.617647	29.250931	1.831984	1.251704	
9	941.0	52.793912	23.331763	132.468037	0.897044	0.954361	0.568237	34.613847	2.262749	1.483962	
10	628.0	44.928348	18.182379	106.568542	0.914451	0.964670	0.581481	28.277101	2.470983	1.439092	
11	807.0	50.646451	20.737643	119.698485	0.912329	0.950530	0.817629	32.054708	2.442247	1.412843	
12	882.0	51.015883	22.258238	124.367532	0.899801	0.960784	0.563939	33.511152	2.292000	1.395518	
13	642.0	42.632085	19.495106	104.526912	0.889319	0.956781	0.764286	28.590554	2.186810	1.354289	
14	914.0	54.754066	21.623228	129.438600	0.918717	0.951093	0.520798	34.113647	2.532187	1.458719	
15	926.0	57.234246	21.042695	134.568542	0.929961	0.954639	0.597419	34.336858	2.719910	1.556203	
16	933.0	52.443252	22.917230	128.568542	0.899466	0.962848	0.666429	34.466397	2.288377	1.409866	
17	798.0	50.613136	20.576724	119.438600	0.913629	0.957983	0.521569	31.875463	2.459728	1.422580	
18	720.0	44.282884	21.187222	111.597980	0.878114	0.956175	0.728008	30.277590	2.090075	1.376481	
19	859.0	53.744165	20.717436	128.124892	0.922715	0.950221	0.527641	33.071329	2.594151	1.520772	
20	1050.0	57.697126	23.607305	138.024387	0.912463	0.959781	0.543478	36.563664	2.444037	1.443818	
21	821.0	48.442649	22.331106	124.124892	0.887410	0.952436	0.557745	32.331558	2.169290	1.493361	
22	860.0	49.880146	22.290983	122.710678	0.894588	0.959821	0.566908	33.090573	2.237683	1.393338	
23	759.0	46.327132	21.293222	114.225397	0.888112	0.955919	0.592969	31.086795	2.175675	1.367961	
24	876.0	53.997930	21.051092	127.840620	0.920878	0.955289	0.700800	33.396974	2.565089	1.484649	
25	741.0	44.686053	21.459363	108.870058	0.877145	0.980159	0.882143	30.715965	2.082357	1.272884	

In [ ]:

Sample2_4

In [43]:

```
import pandas as pd
import numpy as np
from skimage.measure import regionprops, regionprops_table

props_Sample2_4 = regionprops_table(img_labels_Sample2_4, properties=('area', 'major_axis_length', 'minor_axis_

# Create empty lists to store property values
equiv_diameters = []
aspect_ratios = []
compactnesses = []
roundnesses = []
categories = []
```

```
for idx, region in enumerate(regionprops(img_labels_Sample2_4)):
    # Calculate properties for each region
    equiv_diameter = np.sqrt(4 * region.area / np.pi)
    aspect_ratio = region.major_axis_length / region.minor_axis_length
    compactness = (region.perimeter ** 2) / (4 * np.pi * region.area)
    roundness = (4 * region.area) / (np.pi * (region.major_axis_length ** 2))

    # Append the calculated values to the respective lists
    equiv_diameters.append(equiv_diameter)
    aspect_ratios.append(aspect_ratio)
    compactnesses.append(compactness)
    roundnesses.append(roundness)
    categories.append('Small Broke')  # Category 2 for Small

# Create a dictionary with all the properties
props_Sample2_4 = {
    'area': props_Sample1_4['area'],
    'major_axis_length': props_Sample2_4['major_axis_length'],
    'minor_axis_length': props_Sample2_4['minor_axis_length'],
    'perimeter': props_Sample2_4['perimeter'],
    'eccentricity': props_Sample2_4['eccentricity'],
    'solidity': props_Sample2_4['solidity'],
    'extent': props_Sample2_4['extent'],
    'equiv_diameter': equiv_diameters,
    'aspect_ratio': aspect_ratios,
    'compactness': compactnesses,
    'roundness': roundnesses,
    'category': categories,
}

# Create a DataFrame from the dictionary
df_Sample2_4 = pd.DataFrame(props_Sample2_4)
```

In [44]:

```
df_Sample2_4
```

Out[44]:

	area	major_axis_length	minor_axis_length	perimeter	eccentricity	solidity	extent	equiv_diameter	aspect_ratio	compactness	round
0	516.0	34.710176	19.091537	89.154329	0.835147	0.957090	0.612903	25.557228	1.818092	1.232985	0.54
1	523.0	32.274153	21.518863	90.526912	0.745279	0.947559	0.734923	25.829780	1.499808	1.244555	0.64

In [ ]:

Combine

In [50]:

```
csv_file_path = 'Sample2_1.csv'
df_Sample2_1.to_csv(csv_file_path, index=False)
print(f"Data has been exported to {csv_file_path}") # print a message to confirm the export

csv_file_path = 'Sample2_2.csv'
df_Sample2_2.to_csv(csv_file_path, index=False)
print(f"Data has been exported to {csv_file_path}") # print a message to confirm the export

csv_file_path = 'Sample2_3.csv'
df_Sample2_3.to_csv(csv_file_path, index=False)
print(f"Data has been exported to {csv_file_path}") # print a message to confirm the export

csv_file_path = 'Sample2_4.csv'
df_Sample2_4.to_csv(csv_file_path, index=False)
print(f"Data has been exported to {csv_file_path}") # print a message to confirm the export
```

```
Data has been exported to Sample2_1.csv
Data has been exported to Sample2_2.csv
Data has been exported to Sample2_3.csv
Data has been exported to Sample2_4.csv
```

In [51]:

```
import pandas as pd

# List of CSV file names
csv_files = [
    "Sample2_1.csv",
    "Sample2_2.csv",
    "Sample2_3.csv",
    "Sample2_4.csv",
]

# Create an empty DataFrame to store the combined data
combined_prop_data = pd.DataFrame()

# Loop through the CSV files and append their data to the combined_data DataFrame
for file in csv_files:
    df = pd.read_csv(file)  # Read each CSV file
    combined_prop_data = combined_prop_data.append(df, ignore_index=True)  # Append data to the combined DataFr

# Save the combined data to a new CSV file
```

```
combined_prop_data.to_csv("Sample2_Data.csv", index=False)
```

```
C:\Users\LENOVO\AppData\Local\Temp\ipykernel_9256\1012631406.py:17: FutureWarning: The frame.append method is d
eprecated and will be removed from pandas in a future version. Use pandas.concat instead.
  combined_prop_data = combined_prop_data.append(df, ignore_index=True)  # Append data to the combined DataFram
e
C:\Users\LENOVO\AppData\Local\Temp\ipykernel_9256\1012631406.py:17: FutureWarning: The frame.append method is d
eprecated and will be removed from pandas in a future version. Use pandas.concat instead.
  combined_prop_data = combined_prop_data.append(df, ignore_index=True)  # Append data to the combined DataFram
e
C:\Users\LENOVO\AppData\Local\Temp\ipykernel_9256\1012631406.py:17: FutureWarning: The frame.append method is d
eprecated and will be removed from pandas in a future version. Use pandas.concat instead.
  combined_prop_data = combined_prop_data.append(df, ignore_index=True)  # Append data to the combined DataFram
e
C:\Users\LENOVO\AppData\Local\Temp\ipykernel_9256\1012631406.py:17: FutureWarning: The frame.append method is d
eprecated and will be removed from pandas in a future version. Use pandas.concat instead.
  combined_prop_data = combined_prop_data.append(df, ignore_index=True)  # Append data to the combined DataFram
e
```

In [52]:

```
Sample2_Data = pd.read_csv("Sample2_Data.csv")
```

In [53]:

```
Sample2_Data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 400 entries, 0 to 399
Data columns (total 12 columns):
 #   Column             Non-Null Count  Dtype  
---  ------             --------------  -----  
 0   area               400 non-null    float64
 1   major_axis_length  400 non-null    float64
 2   minor_axis_length  400 non-null    float64
 3   perimeter          400 non-null    float64
 4   eccentricity       400 non-null    float64
 5   solidity           400 non-null    float64
 6   extent             400 non-null    float64
 7   equiv_diameter     400 non-null    float64
 8   aspect_ratio       400 non-null    float64
 9   compactness        400 non-null    float64
 10  roundness          400 non-null    float64
 11  category           400 non-null    object 
dtypes: float64(11), object(1)
memory usage: 37.6+ KB
```

In [54]:

```
Sample2_Data
```

Out[54]:

	area	major_axis_length	minor_axis_length	perimeter	eccentricity	solidity	extent	equiv_diameter	aspect_ratio	compactness	r
0	1260.0	71.496582	22.703544	162.409163	0.948242	0.964778	0.477273	40.053487	3.149138	1.665868	
1	1104.0	67.751054	21.023568	150.669048	0.950637	0.970123	0.796537	37.492085	3.222624	1.636323	
2	948.0	58.390897	20.900842	133.254834	0.933742	0.961460	0.769481	34.742353	2.793710	1.490554	
3	1047.0	70.367938	19.187485	159.195959	0.962107	0.948370	0.481158	36.511393	3.667387	1.926227	
4	1148.0	66.868341	22.100976	152.610173	0.943801	0.963087	0.530009	38.231911	3.025583	1.614415	
...	...	...	...	...	...	...	...	...	...	...	
395	759.0	46.327132	21.293222	114.225397	0.888112	0.955919	0.592969	31.086795	2.175675	1.367961	
396	876.0	53.997930	21.051092	127.840620	0.920878	0.955289	0.700800	33.396974	2.565089	1.484649	
397	741.0	44.686053	21.459363	108.870058	0.877145	0.980159	0.882143	30.715965	2.082357	1.272884	
398	516.0	34.710176	19.091537	89.154329	0.835147	0.957090	0.612903	25.557228	1.818092	1.232985	
399	523.0	32.274153	21.518863	90.526912	0.745279	0.947559	0.734923	25.829780	1.499808	1.244555	

400 rows × 12 columns

In [55]:

```
unique_categories = Sample2_Data['category'].unique()
print(unique_categories)
```

```
['Whole Rice' 'Head rice' 'Big Broke' 'Small Broke']
```

In [47]:

```
#####################     Sample2: CSV file is Sample2_Data.csv     #####################
```

In [ ]:

```

```

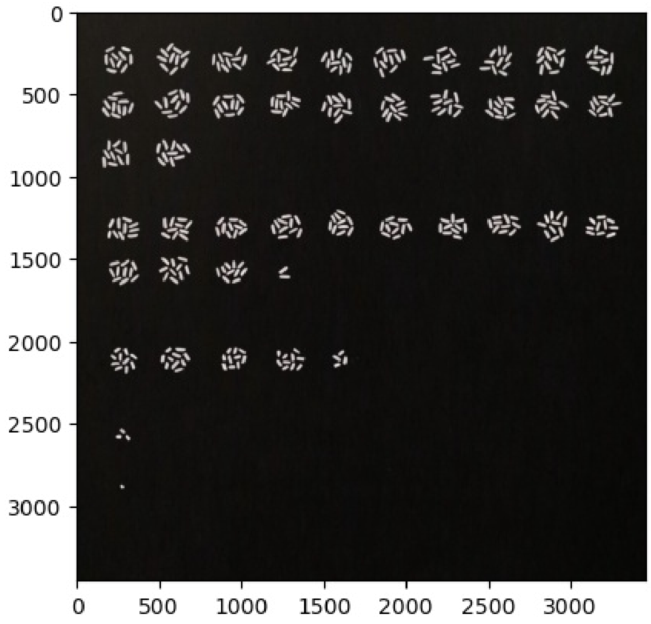
Sample 2 Rice Grade 10%

Sample 3 Rice Grade 10%

```
In [56]: Img_Sample3 = cv2.imread("D:\\Test_Al\\Images_Datasets\\02_Testing_images\\Sample3\\Sample3.jpg")
```

```
In [57]: plt.imshow(Img_Sample3)
```

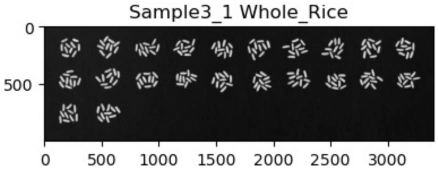
```
Out[57]: <matplotlib.image.AxesImage at 0x2d78ed19350>
```

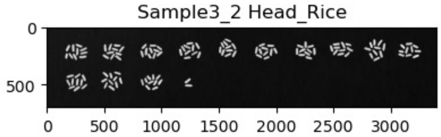


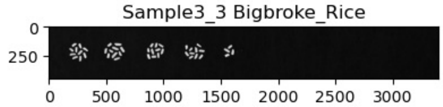
```
In [58]: Img_Sample3_1 = cv2.imread("D:\\Test_Al\\Images_Datasets\\02_Testing_images\\Sample3\\Sample3_1.jpg")
         Img_Sample3_2 = cv2.imread("D:\\Test_Al\\Images_Datasets\\02_Testing_images\\Sample3\\Sample3_2.jpg")
         Img_Sample3_3 = cv2.imread("D:\\Test_Al\\Images_Datasets\\02_Testing_images\\Sample3\\Sample3_3.jpg")
         Img_Sample3_4 = cv2.imread("D:\\Test_Al\\Images_Datasets\\02_Testing_images\\Sample3\\Sample3_4.jpg")
         Img_Sample3_5 = cv2.imread("D:\\Test_Al\\Images_Datasets\\02_Testing_images\\Sample3\\Sample3_5.jpg")
```

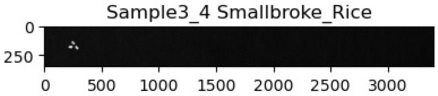
```
In [59]: Img_Sample3_1_Gray=rgb2gray(Img_Sample3_1)
         Img_Sample3_2_Gray=rgb2gray(Img_Sample3_2)
         Img_Sample3_3_Gray=rgb2gray(Img_Sample3_3)
         Img_Sample3_4_Gray=rgb2gray(Img_Sample3_4)
         Img_Sample3_5_Gray=rgb2gray(Img_Sample3_5)
```

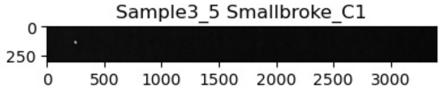
```
In [60]: # Create a figure with subplots to display the images
         plt.figure(figsize=(12, 5))


         # Display the second image sample
         plt.subplot(2, 3, 1)
         plt.imshow(Img_Sample3_1_Gray, cmap='gray')
         plt.title('Sample3_1 Whole_Rice')

         # Display the third image sample
         plt.subplot(2, 3, 2)
         plt.imshow(Img_Sample3_2_Gray, cmap='gray')
         plt.title('Sample3_2 Head_Rice')

         # Display the fourth image sample
         plt.subplot(2, 3, 3)
         plt.imshow(Img_Sample3_3_Gray, cmap='gray')
         plt.title('Sample3_3 Bigbroke_Rice')

         # Display the fourth image sample
         plt.subplot(2, 3, 4)
         plt.imshow(Img_Sample3_4_Gray, cmap='gray')
         plt.title('Sample3_4 Smallbroke_Rice')

         # Display the fifth  image sample
         plt.subplot(2, 3, 5)
         plt.imshow(Img_Sample3_5_Gray, cmap='gray')
         plt.title('Sample3_5 Smallbroke_C1')


         # Adjust spacing between subplots
         plt.tight_layout()

         # Show the plot
         plt.show()
```


Sample3_1 Whole_Rice


Sample3_2 Head_Rice


Sample3_3 Bigbroke_Rice


Sample3_4 Smallbroke_Rice


Sample3_5 Smallbroke_C1

In [61]:

```
threshold_Img_Sample3_1 = filters.threshold_otsu(Img_Sample3_1_Gray)
threshold_Img_Sample3_2 = filters.threshold_otsu(Img_Sample3_2_Gray)
threshold_Img_Sample3_3 = filters.threshold_otsu(Img_Sample3_3_Gray)
threshold_Img_Sample3_4 = filters.threshold_otsu(Img_Sample3_4_Gray)
threshold_Img_Sample3_5 = filters.threshold_otsu(Img_Sample3_5_Gray)
```

In [62]:

```
# Sample3_1
img_mask_Sample3_1 = Img_Sample3_1_Gray > threshold_Img_Sample3_1
img_mask_Sample3_1 = morphology.remove_small_objects(img_mask_Sample3_1, 15)
img_mask_Sample3_1 = morphology.remove_small_holes(img_mask_Sample3_1, 15)

# Sample3_2
img_mask_Sample3_2 = Img_Sample3_2_Gray > threshold_Img_Sample3_2
img_mask_Sample3_2 = morphology.remove_small_objects(img_mask_Sample3_2, 15)
img_mask_Sample3_2 = morphology.remove_small_holes(img_mask_Sample3_2, 15)

# Sample3_3
img_mask_Sample3_3 = Img_Sample3_3_Gray > threshold_Img_Sample3_3
img_mask_Sample3_3 = morphology.remove_small_objects(img_mask_Sample3_3, 15)
img_mask_Sample3_3 = morphology.remove_small_holes(img_mask_Sample3_3, 15)

# Sample3_4
img_mask_Sample3_4 = Img_Sample3_4_Gray > threshold_Img_Sample3_4
img_mask_Sample3_4 = morphology.remove_small_objects(img_mask_Sample3_4, 15)
img_mask_Sample3_4 = morphology.remove_small_holes(img_mask_Sample3_4, 15)

# Sample3_5
img_mask_Sample3_5 = Img_Sample3_5_Gray > threshold_Img_Sample3_5
img_mask_Sample3_5 = morphology.remove_small_objects(img_mask_Sample3_5, 15)
img_mask_Sample3_5 = morphology.remove_small_holes(img_mask_Sample3_5, 15)
```

In [63]:

```
img_labels_Sample3_1 = measure.label(img_mask_Sample3_1)
img_labels_Sample3_2 = measure.label(img_mask_Sample3_2)
img_labels_Sample3_3 = measure.label(img_mask_Sample3_3)
img_labels_Sample3_4 = measure.label(img_mask_Sample3_4)
img_labels_Sample3_5 = measure.label(img_mask_Sample3_5)
```

In [ ]:

Sample3_1

In [64]:

```
import pandas as pd
import numpy as np
from skimage.measure import regionprops, regionprops_table

props_Sample3_1 = regionprops_table(img_labels_Sample3_1, properties=('area', 'major_axis_length', 'minor_axis_

# Create empty lists to store property values
equiv_diameters = []
aspect_ratios = []
compactnesses = []
roundnesses = []
categories = []


for idx, region in enumerate(regionprops(img_labels_Sample3_1)):
    # Calculate properties for each region
    equiv_diameter = np.sqrt(4 * region.area / np.pi)
    aspect_ratio = region.major_axis_length / region.minor_axis_length
    compactness = (region.perimeter ** 2) / (4 * np.pi * region.area)
    roundness = (4 * region.area) / (np.pi * (region.major_axis_length ** 2))

    # Append the calculated values to the respective lists
    equiv_diameters.append(equiv_diameter)
    aspect_ratios.append(aspect_ratio)
    compactnesses.append(compactness)
    roundnesses.append(roundness)
    categories.append('Whole Rice')  # Category 5 for Whole
```

```
# Create a dictionary with all the properties
props_Sample3_1 = {
    'area': props_Sample3_1['area'],
    'major_axis_length': props_Sample3_1['major_axis_length'],
    'minor_axis_length': props_Sample3_1['minor_axis_length'],
    'perimeter': props_Sample3_1['perimeter'],
    'eccentricity': props_Sample3_1['eccentricity'],
    'solidity': props_Sample3_1['solidity'],
    'extent': props_Sample3_1['extent'],
    'equiv_diameter': equiv_diameters,
    'aspect_ratio': aspect_ratios,
    'compactness': compactnesses,
    'roundness': roundnesses,
    'category': categories,
}

# Create a DataFrame from the dictionary
df_Sample3_1 = pd.DataFrame(props_Sample3_1)
```

In [65]:
```
df_Sample3_1
```

Out[65]:

	area	major_axis_length	minor_axis_length	perimeter	eccentricity	solidity	extent	equiv_diameter	aspect_ratio	compactness	r
0	1117.0	65.854698	22.142203	151.823376	0.941781	0.955518	0.458162	37.712181	2.974171	1.642155	
1	1038.0	62.841487	21.275411	143.012193	0.940946	0.960222	0.810304	36.354128	2.953714	1.567974	
2	1128.0	64.224762	22.707464	149.740115	0.935411	0.947899	0.696296	37.897417	2.828355	1.581821	
3	1019.0	65.666510	19.924394	151.497475	0.952858	0.947907	0.746520	36.019871	3.295785	1.792366	
4	1056.0	66.481353	20.553220	151.195959	0.951011	0.942857	0.500711	36.667983	3.234596	1.722688	
...	...	...	...	...	...	...	...	...	...	...	
215	1195.0	72.076350	21.489217	163.639610	0.954521	0.956000	0.605984	39.006682	3.354071	1.783196	
216	1094.0	66.449099	21.402370	152.953319	0.946710	0.957968	0.536275	37.321898	3.104754	1.701730	
217	1174.0	68.665825	22.011427	155.497475	0.947229	0.958367	0.752564	38.662427	3.119553	1.638961	
218	1103.0	68.698729	20.891757	151.722871	0.952638	0.967544	0.432889	37.475101	3.288317	1.660798	
219	1074.0	65.382213	21.143420	148.568542	0.946269	0.955516	0.666253	36.979173	3.092320	1.635459	

220 rows × 12 columns

In [ ]:

Sample3_2

In [66]:
```
import pandas as pd
import numpy as np
from skimage.measure import regionprops, regionprops_table

props_Sample3_2 = regionprops_table(img_labels_Sample3_2, properties=('area', 'major_axis_length', 'minor_axis_

# Create empty lists to store property values
equiv_diameters = []
aspect_ratios = []
compactnesses = []
roundnesses = []
categories = []


for idx, region in enumerate(regionprops(img_labels_Sample3_2)):
    # Calculate properties for each region
    equiv_diameter = np.sqrt(4 * region.area / np.pi)
    aspect_ratio = region.major_axis_length / region.minor_axis_length
    compactness = (region.perimeter ** 2) / (4 * np.pi * region.area)
    roundness = (4 * region.area) / (np.pi * (region.major_axis_length ** 2))

    # Append the calculated values to the respective lists
    equiv_diameters.append(equiv_diameter)
    aspect_ratios.append(aspect_ratio)
    compactnesses.append(compactness)
    roundnesses.append(roundness)
    categories.append('Head rice')  # Category 4 for Head

# Create a dictionary with all the properties
```

```
props_Sample3_2 = {
    'area': props_Sample3_2['area'],
    'major_axis_length': props_Sample3_2['major_axis_length'],
    'minor_axis_length': props_Sample3_2['minor_axis_length'],
    'perimeter': props_Sample3_2['perimeter'],
    'eccentricity': props_Sample3_2['eccentricity'],
    'solidity': props_Sample3_2['solidity'],
    'extent': props_Sample3_2['extent'],
    'equiv_diameter': equiv_diameters,
    'aspect_ratio': aspect_ratios,
    'compactness': compactnesses,
    'roundness': roundnesses,
    'category': categories,
}

# Create a DataFrame from the dictionary
df_Sample3_2 = pd.DataFrame(props_Sample3_2)
```

In [67]:

```
df_Sample3_2
```

Out[67]:

	area	major_axis_length	minor_axis_length	perimeter	eccentricity	solidity	extent	equiv_diameter	aspect_ratio	compactness	r
0	880.0	64.736634	17.488300	145.296465	0.962820	0.942184	0.489433	33.473135	3.701711	1.909051	
1	936.0	58.142131	20.788439	133.012193	0.933896	0.972973	0.835714	34.521764	2.796849	1.504171	
2	1028.0	68.292229	19.528652	153.237590	0.958242	0.943119	0.426910	36.178588	3.497027	1.817723	
3	926.0	60.729098	19.899182	134.994949	0.944792	0.970650	0.457510	34.336858	3.051839	1.566081	
4	1057.0	60.546495	22.585737	140.183766	0.927819	0.974194	0.883041	36.685340	2.680740	1.479485	
...	...	...	...	...	...	...	...	...	...	...	
127	980.0	59.665131	21.259387	136.509668	0.934367	0.962672	0.494949	35.323855	2.806531	1.513181	
128	1180.0	68.353038	22.376132	154.651804	0.944899	0.967213	0.470494	38.761097	3.054730	1.612940	
129	890.0	64.340515	17.851747	144.710678	0.960738	0.947817	0.494994	33.662786	3.604158	1.872411	
130	1243.0	69.562514	22.973013	158.409163	0.943894	0.968823	0.482531	39.782367	3.028010	1.606496	
131	989.0	60.309184	21.366976	140.811183	0.935135	0.941009	0.583137	35.485686	2.822542	1.595395	

132 rows × 12 columns

In [ ]:

Sample3_3

In [68]:

```
import pandas as pd
import numpy as np
from skimage.measure import regionprops, regionprops_table

props_Sample3_3 = regionprops_table(img_labels_Sample3_3, properties=('area', 'major_axis_length', 'minor_axis_

# Create empty lists to store property values
equiv_diameters = []
aspect_ratios = []
compactnesses = []
roundnesses = []
categories = []


for idx, region in enumerate(regionprops(img_labels_Sample3_3)):
    # Calculate properties for each region
    equiv_diameter = np.sqrt(4 * region.area / np.pi)
    aspect_ratio = region.major_axis_length / region.minor_axis_length
    compactness = (region.perimeter ** 2) / (4 * np.pi * region.area)
    roundness = (4 * region.area) / (np.pi * (region.major_axis_length ** 2))

    # Append the calculated values to the respective lists
    equiv_diameters.append(equiv_diameter)
    aspect_ratios.append(aspect_ratio)
    compactnesses.append(compactness)
    roundnesses.append(roundness)
    categories.append('Big Broke')  # Category 3 for Big Broke

# Create a dictionary with all the properties
props_Sample3_3 = {
    'area': props_Sample3_3['area'],
    'major_axis_length': props_Sample3_3['major_axis_length'],
    'minor_axis_length': props_Sample3_3['minor_axis_length'],
    'perimeter': props_Sample3_3['perimeter'],
    'eccentricity': props_Sample3_3['eccentricity'],
    'solidity': props_Sample3_3['solidity'],
    'extent': props_Sample3_3['extent'],
    'equiv_diameter': equiv_diameters,
    'aspect_ratio': aspect_ratios,
    'compactness': compactnesses,
    'roundness': roundnesses,
    'category': categories,
}

# Create a DataFrame from the dictionary
df_Sample3_3 = pd.DataFrame(props_Sample3_3)
```

In [69]:

```
df_Sample3_3
```

Out[69]:

	area	major_axis_length	minor_axis_length	perimeter	eccentricity	solidity	extent	equiv_diameter	aspect_ratio	compactness	ro
0	751.0	44.494238	22.021156	111.781746	0.868938	0.959132	0.552206	30.922531	2.020522	1.324012	
1	734.0	45.636389	20.874502	113.254834	0.889256	0.954486	0.672161	30.570539	2.186226	1.390617	
2	781.0	47.123331	21.525840	116.710678	0.889570	0.953602	0.581101	31.534110	2.189152	1.387907	
3	1152.0	64.668588	23.029445	151.497475	0.934442	0.960000	0.807854	38.298459	2.808083	1.585435	
4	716.0	42.157815	21.956537	107.053824	0.853668	0.966262	0.604730	30.193369	1.920058	1.273742	
5	593.0	50.286482	15.991070	116.746212	0.948091	0.922240	0.415266	27.477828	3.144660	1.829031	
6	802.0	48.430339	21.698921	120.811183	0.894012	0.954762	0.594074	31.955252	2.231924	1.448205	
7	704.0	51.792389	17.577247	120.367532	0.940650	0.951351	0.470588	29.939283	2.946559	1.637707	
8	732.0	45.156692	20.864599	111.053824	0.886854	0.959371	0.581876	30.528861	2.164273	1.340745	
9	651.0	39.976668	21.281535	101.355339	0.846525	0.970194	0.794872	28.790258	1.878467	1.255748	
10	1087.0	64.089265	21.865153	149.539105	0.940003	0.957709	0.575742	37.202303	2.931114	1.637081	
11	1086.0	58.098914	24.328068	140.267027	0.908108	0.961062	0.538690	37.185187	2.388143	1.441689	
12	866.0	50.956558	22.278838	124.183766	0.899358	0.962222	0.803340	33.205804	2.287218	1.417105	
13	779.0	51.454193	19.937479	120.627417	0.921878	0.965304	0.872340	31.493707	2.580777	1.486431	
14	544.0	39.622528	17.933782	96.710678	0.891706	0.952715	0.515152	26.318099	2.209379	1.368170	
15	769.0	53.192025	19.014720	123.781746	0.933923	0.926506	0.506588	31.290913	2.797413	1.585539	
16	617.0	40.035261	20.053671	102.183766	0.865505	0.952160	0.719114	28.028357	1.996406	1.346694	
17	658.0	43.885348	19.374377	104.953319	0.897273	0.966226	0.541118	28.944630	2.265123	1.332161	
18	844.0	50.342253	21.886806	124.426407	0.900546	0.944072	0.732639	32.781308	2.300119	1.459731	
19	816.0	48.406323	21.663172	118.568542	0.894270	0.962264	0.657005	32.232956	2.234498	1.371005	
20	945.0	55.788982	22.009621	134.225397	0.918889	0.953582	0.605769	34.687337	2.534754	1.517147	
21	1044.0	60.884931	22.144847	143.095454	0.931510	0.960442	0.514793	36.459047	2.749395	1.560779	
22	908.0	55.203432	21.455320	131.740115	0.921382	0.952781	0.617687	34.001493	2.572948	1.521039	
23	874.0	51.101966	22.225197	125.254834	0.900470	0.951034	0.713469	33.358827	2.299281	1.428459	
24	638.0	43.139481	19.358165	107.053824	0.893665	0.952239	0.545299	28.501348	2.228490	1.429466	
25	870.0	53.761816	21.044475	127.769553	0.920204	0.949782	0.741688	33.282404	2.554676	1.493226	
26	932.0	54.954777	21.960222	129.681241	0.916687	0.964803	0.516630	34.447921	2.502469	1.435914	

27	697.0	45.670601	19.868507	111.982756	0.900411	0.954795	0.586207	29.790065	2.298643	1.431725
28	817.0	49.631804	21.544033	121.781746	0.900876	0.944509	0.524390	32.252701	2.303738	1.444550
29	1251.0	70.047581	23.221623	157.722871	0.943451	0.963790	0.472075	39.910183	3.016481	1.582422
30	697.0	48.495966	18.562672	111.455844	0.923845	0.970752	0.860494	29.790065	2.612553	1.418283
31	900.0	54.717671	21.442786	131.053824	0.920016	0.954401	0.580645	33.851375	2.551799	1.518613
32	769.0	50.026059	20.032014	117.941125	0.916327	0.948212	0.779129	31.290913	2.497305	1.439443
33	826.0	46.717083	22.920719	118.083261	0.871369	0.957126	0.705983	32.429861	2.038203	1.343343
34	867.0	58.330495	19.737486	131.597980	0.941012	0.936285	0.750649	33.224971	2.955315	1.589533
35	848.0	52.853933	20.784408	130.811183	0.919435	0.938053	0.563830	32.858897	2.542961	1.605773
36	752.0	43.393557	22.714048	113.982756	0.852061	0.950695	0.617406	30.943111	1.910428	1.374835
37	844.0	50.182854	21.925196	124.669048	0.899507	0.955832	0.639394	32.781308	2.288821	1.465430
38	802.0	50.230114	20.653408	120.367532	0.911556	0.954762	0.527632	31.955252	2.432050	1.437588
39	655.0	44.586790	19.113601	109.882251	0.903455	0.930398	0.532520	28.878572	2.332726	1.466912
40	777.0	44.904637	22.193826	110.769553	0.869323	0.974906	0.840909	31.453253	2.023294	1.256637
41	811.0	54.983656	19.309251	129.396970	0.936307	0.952996	0.551701	32.134052	2.847529	1.642924
42	857.0	51.117654	21.817822	121.112698	0.904339	0.969457	0.850198	33.032806	2.342931	1.362036
43	877.0	59.288204	18.985364	135.982756	0.947343	0.954298	0.590572	33.416030	3.122837	1.677870

In [ ]:

Sample3_4

In [70]:

```
import pandas as pd
import numpy as np
from skimage.measure import regionprops, regionprops_table

props_Sample3_4 = regionprops_table(img_labels_Sample3_4, properties=('area', 'major_axis_length', 'minor_axis_

# Create empty lists to store property values
equiv_diameters = []
aspect_ratios = []
compactnesses = []
roundnesses = []
categories = []


for idx, region in enumerate(regionprops(img_labels_Sample3_4)):
    # Calculate properties for each region
    equiv_diameter = np.sqrt(4 * region.area / np.pi)
    aspect_ratio = region.major_axis_length / region.minor_axis_length
    compactness = (region.perimeter ** 2) / (4 * np.pi * region.area)
    roundness = (4 * region.area) / (np.pi * (region.major_axis_length ** 2))

    # Append the calculated values to the respective lists
    equiv_diameters.append(equiv_diameter)
    aspect_ratios.append(aspect_ratio)
    compactnesses.append(compactness)
    roundnesses.append(roundness)
    categories.append('Small Broke')  # Category 2 for Small

# Create a dictionary with all the properties
props_Sample3_4 = {
    'area': props_Sample3_4['area'],
    'major_axis_length': props_Sample3_4['major_axis_length'],
    'minor_axis_length': props_Sample3_4['minor_axis_length'],
    'perimeter': props_Sample3_4['perimeter'],
    'eccentricity': props_Sample3_4['eccentricity'],
    'solidity': props_Sample3_4['solidity'],
    'extent': props_Sample3_4['extent'],
    'equiv_diameter': equiv_diameters,
    'aspect_ratio': aspect_ratios,
    'compactness': compactnesses,
    'roundness': roundnesses,
    'category': categories,
}

# Create a DataFrame from the dictionary
df_Sample3_4 = pd.DataFrame(props_Sample3_4)
```

In [71]:

```
df_Sample3_4
```

Out[71]:

	area	major_axis_length	minor_axis_length	perimeter	eccentricity	solidity	extent	equiv_diameter	aspect_ratio	compactness	roun
0	594.0	37.251499	20.691983	96.124892	0.831539	0.965854	0.562500	27.500987	1.800287	1.237871	0.5
1	669.0	37.057968	23.222278	99.597980	0.779303	0.963977	0.786134	29.185566	1.595794	1.179954	0.6
2	588.0	36.867721	20.796947	95.296465	0.825709	0.971901	0.576471	27.361741	1.772747	1.229041	0.5

In [ ]:

Sample3_5

In [72]:

```
import pandas as pd
import numpy as np
from skimage.measure import regionprops, regionprops_table

props_Sample3_5 = regionprops_table(img_labels_Sample3_5, properties=('area', 'major_axis_length', 'minor_axis_

# Create empty lists to store property values
equiv_diameters = []
aspect_ratios = []
compactnesses = []
roundnesses = []
categories = []


for idx, region in enumerate(regionprops(img_labels_Sample3_5)):
    # Calculate properties for each region
    equiv_diameter = np.sqrt(4 * region.area / np.pi)
    aspect_ratio = region.major_axis_length / region.minor_axis_length
    compactness = (region.perimeter ** 2) / (4 * np.pi * region.area)
    roundness = (4 * region.area) / (np.pi * (region.major_axis_length ** 2))

    # Append the calculated values to the respective lists
    equiv_diameters.append(equiv_diameter)
    aspect_ratios.append(aspect_ratio)
    compactnesses.append(compactness)
    roundnesses.append(roundness)
    categories.append('Small Broke C1')  # Category 1 for C1

# Create a dictionary with all the properties
props_Sample3_5 = {
    'area': props_Sample3_5['area'],
    'major_axis_length': props_Sample3_5['major_axis_length'],
    'minor_axis_length': props_Sample3_5['minor_axis_length'],
    'perimeter': props_Sample3_5['perimeter'],
    'eccentricity': props_Sample3_5['eccentricity'],
    'solidity': props_Sample3_5['solidity'],
    'extent': props_Sample3_5['extent'],
    'equiv_diameter': equiv_diameters,
    'aspect_ratio': aspect_ratios,
    'compactness': compactnesses,
    'roundness': roundnesses,
    'category': categories,
}

# Create a DataFrame from the dictionary
df_Sample3_5 = pd.DataFrame(props_Sample3_5)
```

In [73]:

```
df_Sample3_5
```

Out[73]:

	area	major_axis_length	minor_axis_length	perimeter	eccentricity	solidity	extent	equiv_diameter	aspect_ratio	compactness	roun
0	368.0	24.957233	18.894142	70.183766	0.653345	0.968421	0.730159	21.646066	1.320898	1.065162	0.7

In [ ]:

Combine

In [74]:

```
csv_file_path = 'Sample3_1.csv'
```

```
df_Sample3_1.to_csv(csv_file_path, index=False)
print(f"Data has been exported to {csv_file_path}") # print a message to confirm the export

csv_file_path = 'Sample3_2.csv'
df_Sample3_2.to_csv(csv_file_path, index=False)
print(f"Data has been exported to {csv_file_path}") # print a message to confirm the export

csv_file_path = 'Sample3_3.csv'
df_Sample3_3.to_csv(csv_file_path, index=False)
print(f"Data has been exported to {csv_file_path}") # print a message to confirm the export

csv_file_path = 'Sample3_4.csv'
df_Sample3_4.to_csv(csv_file_path, index=False)
print(f"Data has been exported to {csv_file_path}") # print a message to confirm the export

csv_file_path = 'Sample3_5.csv'
df_Sample3_5.to_csv(csv_file_path, index=False)
print(f"Data has been exported to {csv_file_path}") # print a message to confirm the export
```

```
Data has been exported to Sample3_1.csv
Data has been exported to Sample3_2.csv
Data has been exported to Sample3_3.csv
Data has been exported to Sample3_4.csv
Data has been exported to Sample3_5.csv
```

In [75]:

```
import pandas as pd

# List of CSV file names
csv_files = [
    "Sample3_1.csv",
    "Sample3_2.csv",
    "Sample3_3.csv",
    "Sample3_4.csv",
    "Sample3_5.csv",
]

# Create an empty DataFrame to store the combined data
combined_prop_data = pd.DataFrame()

# Loop through the CSV files and append their data to the combined_data DataFrame
for file in csv_files:
    df = pd.read_csv(file)  # Read each CSV file
    combined_prop_data = combined_prop_data.append(df, ignore_index=True)  # Append data to the combined DataFr

# Save the combined data to a new CSV file
combined_prop_data.to_csv("Sample3_Data.csv", index=False)
```

```
C:\Users\LENOVO\AppData\Local\Temp\ipykernel_9256\2920714122.py:18: FutureWarning: The frame.append method is d
eprecated and will be removed from pandas in a future version. Use pandas.concat instead.
  combined_prop_data = combined_prop_data.append(df, ignore_index=True)  # Append data to the combined DataFram
e
C:\Users\LENOVO\AppData\Local\Temp\ipykernel_9256\2920714122.py:18: FutureWarning: The frame.append method is d
eprecated and will be removed from pandas in a future version. Use pandas.concat instead.
  combined_prop_data = combined_prop_data.append(df, ignore_index=True)  # Append data to the combined DataFram
e
C:\Users\LENOVO\AppData\Local\Temp\ipykernel_9256\2920714122.py:18: FutureWarning: The frame.append method is d
eprecated and will be removed from pandas in a future version. Use pandas.concat instead.
  combined_prop_data = combined_prop_data.append(df, ignore_index=True)  # Append data to the combined DataFram
e
C:\Users\LENOVO\AppData\Local\Temp\ipykernel_9256\2920714122.py:18: FutureWarning: The frame.append method is d
eprecated and will be removed from pandas in a future version. Use pandas.concat instead.
  combined_prop_data = combined_prop_data.append(df, ignore_index=True)  # Append data to the combined DataFram
e
C:\Users\LENOVO\AppData\Local\Temp\ipykernel_9256\2920714122.py:18: FutureWarning: The frame.append method is d
eprecated and will be removed from pandas in a future version. Use pandas.concat instead.
  combined_prop_data = combined_prop_data.append(df, ignore_index=True)  # Append data to the combined DataFram
e
```

In [76]:

```
Sample3_Data = pd.read_csv("Sample3_Data.csv")
```

In [77]:

```
Sample3_Data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 400 entries, 0 to 399
Data columns (total 12 columns):
 #   Column             Non-Null Count  Dtype  
---  ------             --------------  -----  
 0   area               400 non-null    float64
 1   major_axis_length  400 non-null    float64
 2   minor_axis_length  400 non-null    float64
 3   perimeter          400 non-null    float64
 4   eccentricity       400 non-null    float64
 5   solidity           400 non-null    float64
 6   extent             400 non-null    float64
 7   equiv_diameter     400 non-null    float64
 8   aspect_ratio       400 non-null    float64
 9   compactness        400 non-null    float64
 10  roundness          400 non-null    float64
 11  category           400 non-null    object 
dtypes: float64(11), object(1)
memory usage: 37.6+ KB
```

In [78]:

```
Sample3_Data
```

Out[78]:

	area	major_axis_length	minor_axis_length	perimeter	eccentricity	solidity	extent	equiv_diameter	aspect_ratio	compactness	r
0	1117.0	65.854698	22.142203	151.823376	0.941781	0.955518	0.458162	37.712181	2.974171	1.642155	
1	1038.0	62.841487	21.275411	143.012193	0.940946	0.960222	0.810304	36.354128	2.953714	1.567974	
2	1128.0	64.224762	22.707464	149.740115	0.935411	0.947899	0.696296	37.897417	2.828355	1.581821	
3	1019.0	65.666510	19.924394	151.497475	0.952858	0.947907	0.746520	36.019871	3.295785	1.792366	
4	1056.0	66.481353	20.553220	151.195959	0.951011	0.942857	0.500711	36.667983	3.234596	1.722688	
...	...	...	...	...	...	...	...	...	...	...	
395	877.0	59.288204	18.985364	135.982756	0.947343	0.954298	0.590572	33.416030	3.122837	1.677870	
396	594.0	37.251499	20.691983	96.124892	0.831539	0.965854	0.562500	27.500987	1.800287	1.237871	
397	669.0	37.057968	23.222278	99.597980	0.779303	0.963977	0.786134	29.185566	1.595794	1.179954	
398	588.0	36.867721	20.796947	95.296465	0.825709	0.971901	0.576471	27.361741	1.772747	1.229041	
399	368.0	24.957233	18.894142	70.183766	0.653345	0.968421	0.730159	21.646066	1.320898	1.065162	

400 rows × 12 columns

In [79]:

```
unique_categories = Sample3_Data['category'].unique()
print(unique_categories)
```

```
['Whole Rice' 'Head rice' 'Big Broke' 'Small Broke' 'Small Broke C1']
```

In [80]:

```
#####################     Sample3: CSV file is Sample3_Data.csv     #####################
```

In [ ]:

Sample 4 Rice Grade 15%

In [81]:

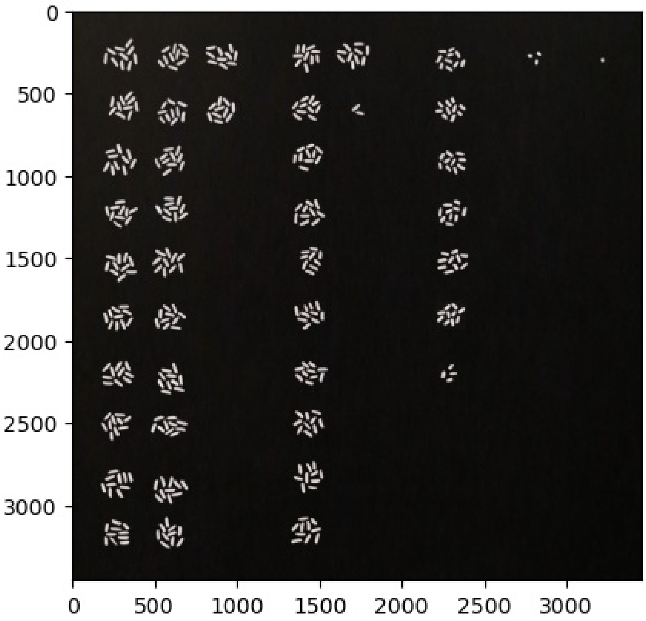
```
Img_Sample4 = cv2.imread("D:\\Test_Al\\Images_Datasets\\02_Testing_images\\Sample4\\Sample4.jpg")
```

In [82]:

```
plt.imshow(Img_Sample4)
```

Out[82]:

```
<matplotlib.image.AxesImage at 0x2d78edce690>
```



In [83]:

```
Img_Sample4_1 = cv2.imread("D:\\Test_Al\\Images_Datasets\\02_Testing_images\\Sample4\\Sample4_1.jpg")
Img_Sample4_2 = cv2.imread("D:\\Test_Al\\Images_Datasets\\02_Testing_images\\Sample4\\Sample4_2.jpg")
Img_Sample4_3 = cv2.imread("D:\\Test_Al\\Images_Datasets\\02_Testing_images\\Sample4\\Sample4_3.jpg")
Img_Sample4_4 = cv2.imread("D:\\Test_Al\\Images_Datasets\\02_Testing_images\\Sample4\\Sample4_4.jpg")
Img_Sample4_5 = cv2.imread("D:\\Test_Al\\Images_Datasets\\02_Testing_images\\Sample4\\Sample4_5.jpg")
```

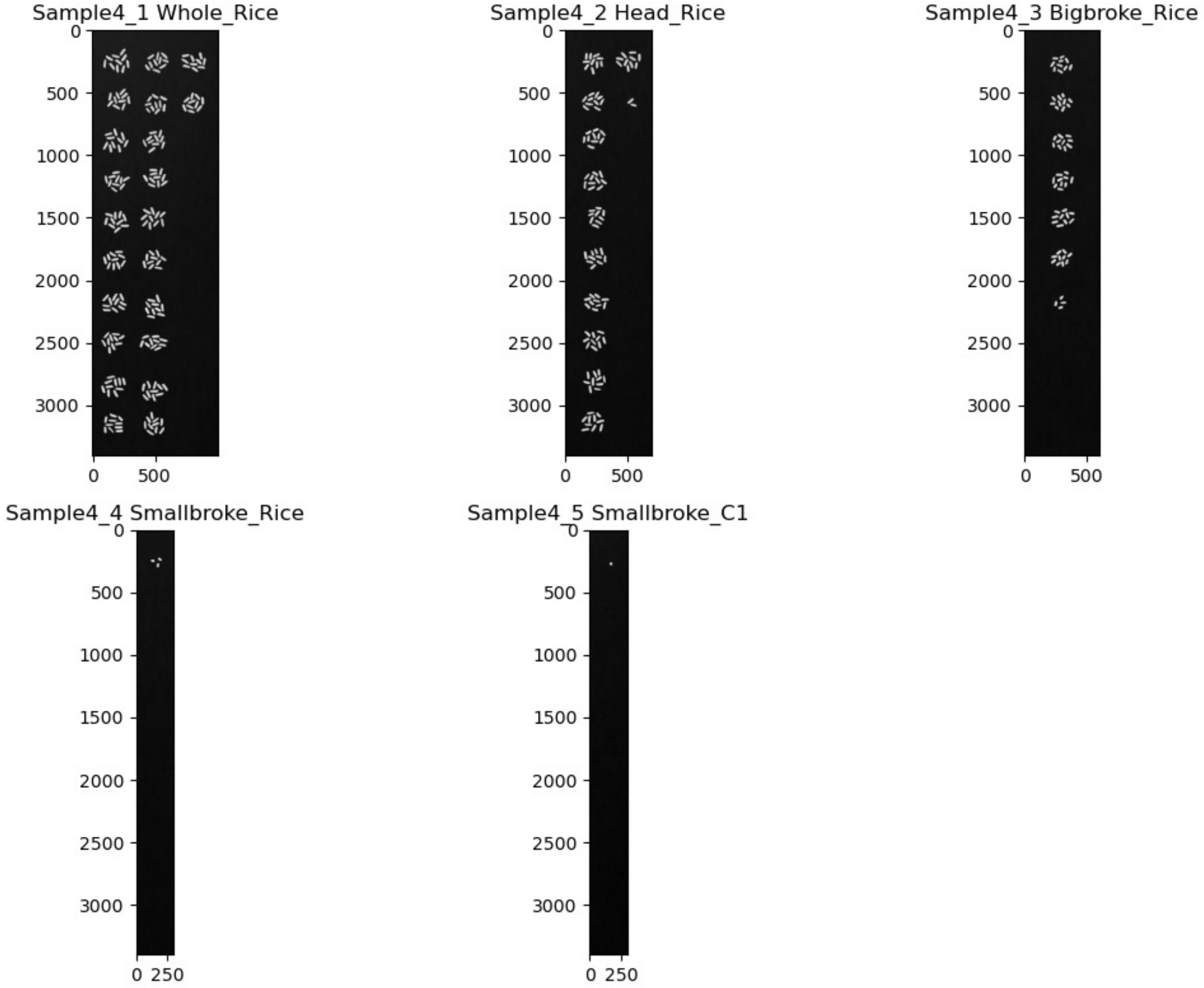
In [84]:

```
Img_Sample4_1_Gray=rgb2gray(Img_Sample4_1)
Img_Sample4_2_Gray=rgb2gray(Img_Sample4_2)
Img_Sample4_3_Gray=rgb2gray(Img_Sample4_3)
Img_Sample4_4_Gray=rgb2gray(Img_Sample4_4)
Img_Sample4_5_Gray=rgb2gray(Img_Sample4_5)
```

In [85]:

```
# Create a figure with subplots to display the images
plt.figure(figsize=(12, 8))


# Display the second image sample
plt.subplot(2, 3, 1)
plt.imshow(Img_Sample4_1_Gray, cmap='gray')
plt.title('Sample4_1 Whole_Rice')

# Display the third image sample
plt.subplot(2, 3, 2)
plt.imshow(Img_Sample4_2_Gray, cmap='gray')
plt.title('Sample4_2 Head_Rice')

# Display the fourth image sample
plt.subplot(2, 3, 3)
plt.imshow(Img_Sample4_3_Gray, cmap='gray')
plt.title('Sample4_3 Bigbroke_Rice')

# Display the fourth image sample
plt.subplot(2, 3, 4)
plt.imshow(Img_Sample4_4_Gray, cmap='gray')
plt.title('Sample4_4 Smallbroke_Rice')

# Display the fifth  image sample
plt.subplot(2, 3, 5)
plt.imshow(Img_Sample4_5_Gray, cmap='gray')
plt.title('Sample4_5 Smallbroke_C1')


# Adjust spacing between subplots
plt.tight_layout()

# Show the plot
```

```
plt.show()
```



In [86]:

```
threshold_Img_Sample4_1 = filters.threshold_otsu(Img_Sample4_1_Gray)
threshold_Img_Sample4_2 = filters.threshold_otsu(Img_Sample4_2_Gray)
threshold_Img_Sample4_3 = filters.threshold_otsu(Img_Sample4_3_Gray)
threshold_Img_Sample4_4 = filters.threshold_otsu(Img_Sample4_4_Gray)
threshold_Img_Sample4_5 = filters.threshold_otsu(Img_Sample4_5_Gray)
```

In [87]:

```
# Sample4_1
img_mask_Sample4_1 = Img_Sample4_1_Gray > threshold_Img_Sample4_1
img_mask_Sample4_1 = morphology.remove_small_objects(img_mask_Sample4_1, 15)
img_mask_Sample4_1 = morphology.remove_small_holes(img_mask_Sample4_1, 15)

# Sample4_2
img_mask_Sample4_2 = Img_Sample4_2_Gray > threshold_Img_Sample4_2
img_mask_Sample4_2 = morphology.remove_small_objects(img_mask_Sample4_2, 15)
img_mask_Sample4_2 = morphology.remove_small_holes(img_mask_Sample4_2, 15)

# Sample4_3
img_mask_Sample4_3 = Img_Sample4_3_Gray > threshold_Img_Sample4_3
img_mask_Sample4_3 = morphology.remove_small_objects(img_mask_Sample4_3, 15)
img_mask_Sample4_3 = morphology.remove_small_holes(img_mask_Sample4_3, 15)

# Sample4_4
img_mask_Sample4_4 = Img_Sample4_4_Gray > threshold_Img_Sample4_4
img_mask_Sample4_4 = morphology.remove_small_objects(img_mask_Sample4_4, 15)
img_mask_Sample4_4 = morphology.remove_small_holes(img_mask_Sample4_4, 15)

# Sample4_5
img_mask_Sample4_5 = Img_Sample4_5_Gray > threshold_Img_Sample4_5
img_mask_Sample4_5 = morphology.remove_small_objects(img_mask_Sample4_5, 15)
img_mask_Sample4_5 = morphology.remove_small_holes(img_mask_Sample4_5, 15)
```

In [88]:

```
img_labels_Sample4_1 = measure.label(img_mask_Sample4_1)
img_labels_Sample4_2 = measure.label(img_mask_Sample4_2)
img_labels_Sample4_3 = measure.label(img_mask_Sample4_3)
img_labels_Sample4_4 = measure.label(img_mask_Sample4_4)
img_labels_Sample4_5 = measure.label(img_mask_Sample4_5)
```

In [ ]:

```

```

Sample4_1

Sample4_1

In [89]:
```
import pandas as pd
import numpy as np
from skimage.measure import regionprops, regionprops_table

props_Sample4_1 = regionprops_table(img_labels_Sample4_1, properties=('area', 'major_axis_length', 'minor_axis_

# Create empty lists to store property values
equiv_diameters = []
aspect_ratios = []
compactnesses = []
roundnesses = []
categories = []


for idx, region in enumerate(regionprops(img_labels_Sample4_1)):
    # Calculate properties for each region
    equiv_diameter = np.sqrt(4 * region.area / np.pi)
    aspect_ratio = region.major_axis_length / region.minor_axis_length
    compactness = (region.perimeter ** 2) / (4 * np.pi * region.area)
    roundness = (4 * region.area) / (np.pi * (region.major_axis_length ** 2))

    # Append the calculated values to the respective lists
    equiv_diameters.append(equiv_diameter)
    aspect_ratios.append(aspect_ratio)
    compactnesses.append(compactness)
    roundnesses.append(roundness)
    categories.append('Whole Rice')  # Category 5 for Whole

# Create a dictionary with all the properties
props_Sample4_1 = {
    'area': props_Sample4_1['area'],
    'major_axis_length': props_Sample4_1['major_axis_length'],
    'minor_axis_length': props_Sample4_1['minor_axis_length'],
    'perimeter': props_Sample4_1['perimeter'],
    'eccentricity': props_Sample4_1['eccentricity'],
    'solidity': props_Sample4_1['solidity'],
    'extent': props_Sample4_1['extent'],
    'equiv_diameter': equiv_diameters,
    'aspect_ratio': aspect_ratios,
    'compactness': compactnesses,
    'roundness': roundnesses,
    'category': categories,
}

# Create a DataFrame from the dictionary
df_Sample4_1 = pd.DataFrame(props_Sample4_1)
```

In [90]:
```
df_Sample4_1
```

Out[90]:

	area	major_axis_length	minor_axis_length	perimeter	eccentricity	solidity	extent	equiv_diameter	aspect_ratio	compactness	r
0	1207.0	69.227836	22.512157	158.651804	0.945649	0.960987	0.470565	39.202042	3.075131	1.659483	
1	1023.0	71.645640	18.339173	156.325902	0.966685	0.955182	0.654092	36.090498	3.906700	1.900975	
2	1115.0	62.839069	22.934397	147.740115	0.931019	0.956261	0.662901	37.678404	2.739949	1.557802	
3	1254.0	73.055586	22.097360	165.722871	0.953158	0.960184	0.430189	39.958008	3.306078	1.742840	
4	1078.0	65.568443	21.290971	149.923882	0.945812	0.963360	0.473014	37.047972	3.079636	1.659255	
...	...	...	...	...	...	...	...	...	...	...	
215	966.0	59.291285	21.315682	137.254834	0.933142	0.957384	0.736842	35.070634	2.781580	1.551916	
216	771.0	67.172362	14.958021	145.651804	0.974891	0.948339	0.327806	31.331577	4.490725	2.189614	
217	1033.0	66.212080	20.099647	148.166522	0.952811	0.955597	0.455467	36.266465	3.294191	1.691181	
218	1102.0	74.073716	19.246000	162.651804	0.965656	0.959095	0.408148	37.458110	3.848785	1.910409	
219	1049.0	63.502483	21.420309	142.769553	0.941392	0.965930	0.832540	36.546249	2.964592	1.546272	

220 rows × 12 columns

In [ ]:

Sample4_2

In [91]:

```python
import pandas as pd
import numpy as np
from skimage.measure import regionprops, regionprops_table

props_Sample4_2 = regionprops_table(img_labels_Sample4_2, properties=('area', 'major_axis_length', 'minor_axis_

# Create empty lists to store property values
equiv_diameters = []
aspect_ratios = []
compactnesses = []
roundnesses = []
categories = []


for idx, region in enumerate(regionprops(img_labels_Sample4_2)):
    # Calculate properties for each region
    equiv_diameter = np.sqrt(4 * region.area / np.pi)
    aspect_ratio = region.major_axis_length / region.minor_axis_length
    compactness = (region.perimeter ** 2) / (4 * np.pi * region.area)
    roundness = (4 * region.area) / (np.pi * (region.major_axis_length ** 2))

    # Append the calculated values to the respective lists
    equiv_diameters.append(equiv_diameter)
    aspect_ratios.append(aspect_ratio)
    compactnesses.append(compactness)
    roundnesses.append(roundness)
    categories.append('Head rice')  # Category 4 for Head

# Create a dictionary with all the properties
props_Sample4_2 = {
    'area': props_Sample4_2['area'],
    'major_axis_length': props_Sample4_2['major_axis_length'],
    'minor_axis_length': props_Sample4_2['minor_axis_length'],
    'perimeter': props_Sample4_2['perimeter'],
    'eccentricity': props_Sample4_2['eccentricity'],
    'solidity': props_Sample4_2['solidity'],
    'extent': props_Sample4_2['extent'],
    'equiv_diameter': equiv_diameters,
    'aspect_ratio': aspect_ratios,
    'compactness': compactnesses,
    'roundness': roundnesses,
    'category': categories,
}

# Create a DataFrame from the dictionary
df_Sample4_2 = pd.DataFrame(props_Sample4_2)
```

In [92]:

```python
df_Sample4_2
```

Out[92]:

	area	major_axis_length	minor_axis_length	perimeter	eccentricity	solidity	extent	equiv_diameter	aspect_ratio	compactness	r
0	1003.0	64.672023	20.042389	141.941125	0.950766	0.970958	0.865401	35.735966	3.226762	1.598474	
1	1151.0	66.654847	22.308238	150.994949	0.942331	0.964795	0.479583	38.281833	2.987903	1.576303	
2	978.0	59.463095	21.458806	138.083261	0.932614	0.959764	0.733133	35.287792	2.771035	1.551434	
3	930.0	58.364007	20.508797	133.254834	0.936227	0.958763	0.754870	34.410940	2.845804	1.519404	
4	1041.0	67.569022	20.050692	153.195959	0.954957	0.952425	0.490113	36.406625	3.369910	1.794048	
...	...	...	...	...	...	...	...	...	...	...	
107	1133.0	69.261387	21.160384	157.053824	0.952187	0.954507	0.590104	37.981317	3.273163	1.732436	
108	854.0	64.199528	17.271271	138.769553	0.963133	0.955257	0.777778	32.974939	3.717128	1.794406	
109	1123.0	67.011089	21.615029	153.982756	0.946549	0.949281	0.624583	37.813331	3.100208	1.680175	
110	1149.0	67.654789	22.070700	154.166522	0.945292	0.960702	0.479950	38.248559	3.065367	1.646077	
111	1094.0	69.139275	20.533262	154.325902	0.954882	0.952962	0.657452	37.321898	3.367184	1.732409	

112 rows × 12 columns

In [ ]:

Sample4_3

In [93]:

```python
import pandas as pd
import numpy as np
from skimage.measure import regionprops, regionprops_table

props_Sample4_3 = regionprops_table(img_labels_Sample4_3, properties=('area', 'major_axis_length', 'minor_axis_

# Create empty lists to store property values
equiv_diameters = []
aspect_ratios = []
compactnesses = []
roundnesses = []
categories = []


for idx, region in enumerate(regionprops(img_labels_Sample4_3)):
    # Calculate properties for each region
    equiv_diameter = np.sqrt(4 * region.area / np.pi)
    aspect_ratio = region.major_axis_length / region.minor_axis_length
    compactness = (region.perimeter ** 2) / (4 * np.pi * region.area)
    roundness = (4 * region.area) / (np.pi * (region.major_axis_length ** 2))

    # Append the calculated values to the respective lists
    equiv_diameters.append(equiv_diameter)
    aspect_ratios.append(aspect_ratio)
    compactnesses.append(compactness)
    roundnesses.append(roundness)
    categories.append('Big Broke')  # Category 3 for Big Broke

# Create a dictionary with all the properties
props_Sample4_3 = {
    'area': props_Sample4_3['area'],
    'major_axis_length': props_Sample4_3['major_axis_length'],
    'minor_axis_length': props_Sample4_3['minor_axis_length'],
    'perimeter': props_Sample4_3['perimeter'],
    'eccentricity': props_Sample4_3['eccentricity'],
    'solidity': props_Sample4_3['solidity'],
    'extent': props_Sample4_3['extent'],
    'equiv_diameter': equiv_diameters,
    'aspect_ratio': aspect_ratios,
    'compactness': compactnesses,
    'roundness': roundnesses,
    'category': categories,
}

# Create a DataFrame from the dictionary
df_Sample4_3 = pd.DataFrame(props_Sample4_3)
```

In [94]:

```
df_Sample4_3
```

Out[94]:

```
     area  major_axis_length  minor_axis_length   perimeter  eccentricity  solidity    extent  equiv_diameter  aspect_ratio  compactness  rou
 0  625.0          45.056638          18.047198  107.154329      0.916277  0.960061  0.578704       28.209479      2.496600     1.461940    0
 1  803.0          50.555159          20.667003  120.526912      0.912624  0.948052  0.813576       31.975168      2.446178     1.439603    0
 2  882.0          50.972023          22.282232  123.539105      0.899390  0.963934  0.576471       33.511152      2.287564     1.376989    0
 3  644.0          42.585406          19.592317  104.526912      0.887882  0.954074  0.750583       28.635053      2.173577     1.350083    0
 4  915.0          54.858577          21.610997  129.438600      0.919136  0.951143  0.521368       34.132304      2.538457     1.457124    0
...   ...                ...                ...         ...           ...       ...       ...             ...           ...          ...
59  729.0          45.100271          20.804506  111.053824      0.887247  0.959211  0.579491       30.466238      2.167813     1.346262    0
60  669.0          40.343059          21.647750  105.053824      0.843842  0.958453  0.578720       29.185566      1.863614     1.312767    0
61  789.0          44.887273          22.924573  115.941125      0.859750  0.959854  0.740150       31.695205      1.958042     1.355777    0
62  673.0          47.903863          18.132085  110.526912      0.925597  0.951909  0.787135       29.272687      2.641939     1.444479    0
63  688.0          41.848515          21.352324  107.597980      0.860039  0.956885  0.696356       29.597108      1.959904     1.339091    0

64 rows × 12 columns
```

In [ ]:

Sample4_4

In [97]:

```
import pandas as pd
import numpy as np
```

```
from skimage.measure import regionprops, regionprops_table

props_Sample4_4 = regionprops_table(img_labels_Sample4_4, properties=('area', 'major_axis_length', 'minor_axis_

# Create empty lists to store property values
equiv_diameters = []
aspect_ratios = []
compactnesses = []
roundnesses = []
categories = []


for idx, region in enumerate(regionprops(img_labels_Sample4_4)):
    # Calculate properties for each region
    equiv_diameter = np.sqrt(4 * region.area / np.pi)
    aspect_ratio = region.major_axis_length / region.minor_axis_length
    compactness = (region.perimeter ** 2) / (4 * np.pi * region.area)
    roundness = (4 * region.area) / (np.pi * (region.major_axis_length ** 2))

    # Append the calculated values to the respective lists
    equiv_diameters.append(equiv_diameter)
    aspect_ratios.append(aspect_ratio)
    compactnesses.append(compactness)
    roundnesses.append(roundness)
    categories.append('Small Broke')  # Category 2 for Small

# Create a dictionary with all the properties
props_Sample4_4 = {
    'area': props_Sample4_4['area'],
    'major_axis_length': props_Sample4_4['major_axis_length'],
    'minor_axis_length': props_Sample4_4['minor_axis_length'],
    'perimeter': props_Sample4_4['perimeter'],
    'eccentricity': props_Sample4_4['eccentricity'],
    'solidity': props_Sample4_4['solidity'],
    'extent': props_Sample4_4['extent'],
    'equiv_diameter': equiv_diameters,
    'aspect_ratio': aspect_ratios,
    'compactness': compactnesses,
    'roundness': roundnesses,
    'category': categories,
}

# Create a DataFrame from the dictionary
df_Sample4_4 = pd.DataFrame(props_Sample4_4)
```

In [98]:

```
df_Sample4_4
```

Out[98]:

	area	major_axis_length	minor_axis_length	perimeter	eccentricity	solidity	extent	equiv_diameter	aspect_ratio	compactness	rounc
0	502.0	33.505504	19.253170	89.497475	0.818415	0.956190	0.669333	25.281738	1.740259	1.269720	0.56
1	478.0	31.145639	19.771499	83.355339	0.772670	0.957916	0.758730	24.669992	1.575280	1.156722	0.62
2	558.0	34.705836	20.735185	91.355339	0.801902	0.962069	0.768595	26.654599	1.673765	1.190211	0.58

In [ ]:

Sample4_5

In [99]:

```
import pandas as pd
import numpy as np
from skimage.measure import regionprops, regionprops_table

props_Sample4_5 = regionprops_table(img_labels_Sample4_5, properties=('area', 'major_axis_length', 'minor_axis_

# Create empty lists to store property values
equiv_diameters = []
aspect_ratios = []
compactnesses = []
roundnesses = []
categories = []


for idx, region in enumerate(regionprops(img_labels_Sample4_5)):
    # Calculate properties for each region
    equiv_diameter = np.sqrt(4 * region.area / np.pi)
    aspect_ratio = region.major_axis_length / region.minor_axis_length
    compactness = (region.perimeter ** 2) / (4 * np.pi * region.area)
    roundness = (4 * region.area) / (np.pi * (region.major_axis_length ** 2))

    # Append the calculated values to the respective lists
    equiv_diameters.append(equiv_diameter)
    aspect_ratios.append(aspect_ratio)
    compactnesses.append(compactness)
    roundnesses.append(roundness)
    categories.append('Small Broke C1')  # Category 1 for C1

# Create a dictionary with all the properties
props_Sample4_5 = {
    'area': props_Sample4_5['area'],
    'major_axis_length': props_Sample4_5['major_axis_length'],
    'minor_axis_length': props_Sample4_5['minor_axis_length'],
    'perimeter': props_Sample4_5['perimeter'],
    'eccentricity': props_Sample4_5['eccentricity'],
    'solidity': props_Sample4_5['solidity'],
    'extent': props_Sample4_5['extent'],
    'equiv_diameter': equiv_diameters,
    'aspect_ratio': aspect_ratios,
    'compactness': compactnesses,
    'roundness': roundnesses,
    'category': categories,
}

# Create a DataFrame from the dictionary
df_Sample4_5 = pd.DataFrame(props_Sample4_5)
```

In [100…

```
df_Sample4_5
```

Out[100]:

	area	major_axis_length	minor_axis_length	perimeter	eccentricity	solidity	extent	equiv_diameter	aspect_ratio	compactness	rounc
0	424.0	24.950905	22.123769	76.870058	0.462361	0.961451	0.80303	23.234749	1.127787	1.109018	0.8€

In [ ]:

Combine

In [101…

```
csv_file_path = 'Sample4_1.csv'
df_Sample4_1.to_csv(csv_file_path, index=False)
print(f"Data has been exported to {csv_file_path}") # print a message to confirm the export

csv_file_path = 'Sample4_2.csv'
df_Sample4_2.to_csv(csv_file_path, index=False)
print(f"Data has been exported to {csv_file_path}") # print a message to confirm the export

csv_file_path = 'Sample4_3.csv'
df_Sample4_3.to_csv(csv_file_path, index=False)
print(f"Data has been exported to {csv_file_path}") # print a message to confirm the export

csv_file_path = 'Sample4_4.csv'
df_Sample4_4.to_csv(csv_file_path, index=False)
print(f"Data has been exported to {csv_file_path}") # print a message to confirm the export

csv_file_path = 'Sample4_5.csv'
df_Sample4_5.to_csv(csv_file_path, index=False)
print(f"Data has been exported to {csv_file_path}") # print a message to confirm the export
```

```
Data has been exported to Sample4_1.csv
Data has been exported to Sample4_2.csv
Data has been exported to Sample4_3.csv
Data has been exported to Sample4_4.csv
Data has been exported to Sample4_5.csv
```

In [102…

```
import pandas as pd

# List of CSV file names
csv_files = [
    "Sample4_1.csv",
    "Sample4_2.csv",
    "Sample4_3.csv",
    "Sample4_4.csv",
    "Sample4_5.csv",
]

# Create an empty DataFrame to store the combined data
combined_prop_data = pd.DataFrame()

# Loop through the CSV files and append their data to the combined_data DataFrame
for file in csv_files:
    df = pd.read_csv(file)  # Read each CSV file
    combined_prop_data = combined_prop_data.append(df, ignore_index=True)  # Append data to the combined DataFr

# Save the combined data to a new CSV file
combined_prop_data.to_csv("Sample4_Data.csv", index=False)
```

```
C:\Users\LENOVO\AppData\Local\Temp\ipykernel_9256\2332497413.py:18: FutureWarning: The frame.append method is d
eprecated and will be removed from pandas in a future version. Use pandas.concat instead.
  combined_prop_data = combined_prop_data.append(df, ignore_index=True)  # Append data to the combined DataFram
e
C:\Users\LENOVO\AppData\Local\Temp\ipykernel_9256\2332497413.py:18: FutureWarning: The frame.append method is d
eprecated and will be removed from pandas in a future version. Use pandas.concat instead.
  combined_prop_data = combined_prop_data.append(df, ignore_index=True)  # Append data to the combined DataFram
e
C:\Users\LENOVO\AppData\Local\Temp\ipykernel_9256\2332497413.py:18: FutureWarning: The frame.append method is d
eprecated and will be removed from pandas in a future version. Use pandas.concat instead.
  combined_prop_data = combined_prop_data.append(df, ignore_index=True)  # Append data to the combined DataFram
e
C:\Users\LENOVO\AppData\Local\Temp\ipykernel_9256\2332497413.py:18: FutureWarning: The frame.append method is d
eprecated and will be removed from pandas in a future version. Use pandas.concat instead.
  combined_prop_data = combined_prop_data.append(df, ignore_index=True)  # Append data to the combined DataFram
e
C:\Users\LENOVO\AppData\Local\Temp\ipykernel_9256\2332497413.py:18: FutureWarning: The frame.append method is d
eprecated and will be removed from pandas in a future version. Use pandas.concat instead.
  combined_prop_data = combined_prop_data.append(df, ignore_index=True)  # Append data to the combined DataFram
e
```

In [103…

```
Sample4_Data = pd.read_csv("Sample4_Data.csv")
```

In [104…

```
Sample4_Data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 400 entries, 0 to 399
Data columns (total 12 columns):
 #   Column             Non-Null Count  Dtype  
---  ------             --------------  -----  
 0   area               400 non-null    float64
 1   major_axis_length  400 non-null    float64
 2   minor_axis_length  400 non-null    float64
 3   perimeter          400 non-null    float64
 4   eccentricity       400 non-null    float64
 5   solidity           400 non-null    float64
 6   extent             400 non-null    float64
 7   equiv_diameter     400 non-null    float64
 8   aspect_ratio       400 non-null    float64
 9   compactness        400 non-null    float64
 10  roundness          400 non-null    float64
 11  category           400 non-null    object 
dtypes: float64(11), object(1)
memory usage: 37.6+ KB
```

In [105…

```
Sample4_Data
```

Out[105]:

	area	major_axis_length	minor_axis_length	perimeter	eccentricity	solidity	extent	equiv_diameter	aspect_ratio	compactness
0	1207.0	69.227836	22.512157	158.651804	0.945649	0.960987	0.470565	39.202042	3.075131	1.659483
1	1023.0	71.645640	18.339173	156.325902	0.966685	0.955182	0.654092	36.090498	3.906700	1.900975
2	1115.0	62.839069	22.934397	147.740115	0.931019	0.956261	0.662901	37.678404	2.739949	1.557802
3	1254.0	73.055586	22.097360	165.722871	0.953158	0.960184	0.430189	39.958008	3.306078	1.742840
4	1078.0	65.568443	21.290971	149.923882	0.945812	0.963360	0.473014	37.047972	3.079636	1.659255
...	...	...	...	...	...	...	...	...	...	...
395	688.0	41.848515	21.352324	107.597980	0.860039	0.956885	0.696356	29.597108	1.959904	1.339091
396	502.0	33.505504	19.253170	89.497475	0.818415	0.956190	0.669333	25.281738	1.740259	1.269720
397	478.0	31.145639	19.771499	83.355339	0.772670	0.957916	0.758730	24.669992	1.575280	1.156722
398	558.0	34.705836	20.735185	91.355339	0.801902	0.962069	0.768595	26.654599	1.673765	1.190211
399	424.0	24.950905	22.123769	76.870058	0.462361	0.961451	0.803030	23.234749	1.127787	1.109018

400 rows × 12 columns

In [106…

```
unique_categories = Sample4_Data['category'].unique()
print(unique_categories)
```

```
['Whole Rice' 'Head rice' 'Big Broke' 'Small Broke' 'Small Broke C1']
```

In [ ]:

```
#####################     Sample4: CSV file is Sample4_Data.csv     #####################
```

In [ ]:

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